OBSERVATIONS

ON THE

VIRTUES

AND

OPERATIONS

OF

MEDICINES.

BY

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PREFACE.

IN a *Dissertation on the Æther*, printed in the year 1743, and in an *Appendix* to that *Dissertation*, printed in the year 1746, I have given an account of those properties of that elastick fluid, which Sir *Isaac Newton* has delivered in his *Opticks*. And in these *Observations on the virtues and operations of medicines*, I have shewn, that the refractive power of a globe, is directly as

 its

its denſity, and inverſly, as the ſquare of the diſtance from its ſurface, to which that power reaches; that is, if d be put for that diſtance, and Δ for the denſity of the globe, as $\frac{\Delta}{d^2}$. If D be put for the diameter of the globe, the force of gravity at its ſurface is, as its diameter and denſity taken together; that is, as DΔ. Therefore, the refractive power of the globe, is to the force of gravity at its ſurface; as $\frac{\Delta}{d^2}$, is to DΔ; or as 1, is to d^2D.

If the diſtance from the ſurface of the globe to which the refractive power reaches, be equal

to

to the diameter of the globe; that is, if d be equal to D; then will the refractive power, be to the force of gravity at the ſurface; as unity, is to the cube of the diameter; that is, as 1 is to D^3. Hence it follows, that if d be the 800th part of an inch, the refractive power of a globe of that diameter, will be to the force of gravity at its ſurface, as 512000000 is to 1.

If the diſtance from the ſurface of the globe, to which the refractive power reaches, be of a given breadth, as Sir *Iſaac Newton* ſuppoſes; the refractive power will then be as the denſity of

the

the globe. But, in order to compare the whole refractive force with the force of gravity at the surface of the globe, the breadth of the small given space through which the refractive force acts, must be taken into the measure; because the *Æther* is gradually condensed by *Light*, through that little space; and the sum of all the increments is as $\frac{\Delta}{d^2}$, the true measure of that force.

Anatomy is arrived at great perfection, and the animal œconomy might be improved, if human bodies were examined by weight and measure. This may be done, if the lengths and

weights

weights of the bodies ſlain in a battle; the weights of their hearts, lungs, livers, ſpleen, pancreas and kidneys, were carefully taken by the Surgeons, who are generally good Anatomiſts; and the diameter of the aorta was meaſured, when moderately extended by warm water.

"All the parts of animals and "vegetables, are compoſed of "ſubſtances volatile and fixed, "fluid and ſolid, as appears "from their analyſis; and ſo "are ſalts and minerals, ſo far "as Chymiſts have been hitherto "able to examine their compo-"ſition."

Now,

Now, by knowing how bodies are changed, as to the magnitudes and densities of their corpuscles of the *last composition*, we may know how the attractive and repulsive powers of the particles are changed; and, by knowing how those powers are changed, we may know the changes made by them, considered as medicines. If the magnitudes of the corpuscles be lessened, their virtues and operations will be increased; and they will be lessened, if the magnitudes of the corpuscles be encreased.

The

The magnitudes of the corpuſcles of bodies exhibiting colours, may be had from the Table of colours in the *Opticks*; and from the ſame Table, but in another form, in the *Diſſertation*. If the colour of a body be known, the thickneſs of the corpuſcles exhibiting that colour, may be got by inſpection; but if that cannot be had, it may often be got by obſerving the colours into which it changes; for all changes of colour are gradual. For inſtance, the colour of venal blood, in a high inflammatory fever, is the beginning of black of the firſt order; for when it

is drawn and ſtands expoſed to the Air till it is cold, it firſt changes into a faint blue, and then, by degrees, into a white, or yellowiſh white; which are the colours of the firſt order gradually ſucceeding each other. The colour of healthful venal blood is compoſed of the purple and indigo of the ſecond order; for it changes by being expoſed to the action of the Air, into the red of the firſt order. Hence the acid of the Air has a different effect upon this blood, from what it has upon blood attenuated by heat, and tending to a ſtate of putrefaction.

We are obliged to Dr. *Russel* for the account he has given of the uſe of *ſea-water* in diſeaſes of the glands. And when it is conſidered, that in theſe diſeaſes there is commonly a want of heat and motion in the blood, and that both are reſtored by frequent vomits, with a proper diet; we muſt allow, that frequent vomits, with a proper diet, will greatly aſſiſt ſea-water, in the cure of the diſeaſes of the glands.

I ſhall ſay no more, but only obſerve, that if this part of Sir *Iſaac Newton*'s philoſophy was cultivated by juſt experiments and

and obſervations, we might hope, in time, to ſee PHYSICK placed upon a certain and demonſtrative foundation.

OBSERVATIONS

ON THE

VIRTUES and OPERATIONS

OF

MEDICINES.

AS the virtues and operations of medicines depend on the powers, virtues or forces of their ſmall particles, and as theſe depend on and are cauſed by the *Æther* and *Light*; ſo it will be neceſſary, in order to explain the virtues and operations of medicines, to give a ſhort account of the *Æther* and

 Light;

Light; which I ſhall do from what has been delivered concerning them, by Sir *Iſaac Newton* himſelf, in his Letter to Mr. *Boyle*, in his *Opticks*, in his *Principles of Philoſophy*; and in a *Diſſertation on the* Æther, printed in this kingdom in the year 1743.

Sir *Iſaac Newton*, in the laſt paragraph of the laſt edition of his *Principles*, publiſhed in the year in which he died, aſſerts the exiſtence of the *Æther*, by expreſly ſaying that it cauſes the Phænomena there mentioned. The paragraph in his own words ſtands thus.

" Adjicere jam liceret nonnulla de ſpi-
" ritu quodam ſubtiliſſimo corpora craſſa
" pervadente et in iiſdem latente; cujus
" vi et actionibus particulæ corporum ad
" minimas diſtantias ſe mutuo attrahunt,
" et contiguæ factæ cohærent; et cor-
" pora electrica agunt ad diſtantias ma-
" jores, tam repellendo quam attrahendo
" corpuſcula vicina; et Lux emittitur,
" reflectitur, refringitur, inflectitur, et
" corpora calefacit; et ſenſatio omnis ex-
" citatur, et membra animalium ad vo-

"luntatem moventur, vibrationibus ſcilicet hujus ſpiritus per ſolida nervorum "capillamenta ab externis ſenſuum organis ad cerebrum, et a cerebro in "muſculos propagatis. Sed hæc paucis "exponi non poſſunt, neque adeſt ſufficiens copia experimentorum, quibus "leges actionum hujus ſpiritus accuratè "determinari et monſtrari debent."

The *Æther* is an exceedingly ſubtile and exceedingly elaſtick Fluid, diffuſed through the univerſe. It is far more ſubtile and more elaſtick than Air, from its particles being exceedingly ſmaller than thoſe of Air, or even than thoſe of *Light*. The exceeding ſmallneſs of its particles contributes to the greatneſs of the force by which thoſe particles recede from one another, and thereby makes the *Æther* exceedingly more rare and elaſtick than Air, and by conſequence exceedingly leſs able to reſiſt the motion of projectiles, and exceedingly more able to preſs upon groſs bodies by endeavouring to expand it ſelf.

The *Æther* presses upon bodies with two very different forces. By one it causes gravity, or a tendency of all bodies to one another. And by the other it causes the Phænomena, mentioned in the foregoing paragraph.

The *Æther* causes gravity, by pervading bodies, and pressing upon all their particles, not according to the quantity of the *surfaces* of the particles on which it acts (as mechanical causes are wont to do) but according to the quantity of their *solid* matter. This pressure of the *Æther* on all the particles of bodies is (by reaction) attended with an equal pressure of all the particles on the *Æther*; whereby it is made to recede, and stand rarer in bodies than without them, rarer in dense bodies than in rare bodies, and rarer in small pores and small pipes than in large pores and large pipes. The condensation of the *Æther*, caused by the pressure of all the matter in the Sun, is extended all around to great distances; but though the density increases continually, yet the increment of the density lessens from the surface, as the

the ſquare of the diſtance from the center of the Sun increaſes. The *Æther* growing denſer and denſer continually from the ſurface of the Sun to *Saturn* and beyond, all bodies placed within that diſtance will gravitate or tend towards the Sun, from the *Æther*'s being denſer on the remoteſt than on the neareſt ſides of all their particles with reſpect to the Sun; and each body will gravitate with a force proportionate to the increment of the denſity at its center of gravity, and its quantity of matter, taken together. The increment of the denſity of the *Æther* at the center of gravity of a body, is as the quantity of matter in the Sun applied to the ſquare of the diſtance from the center of the Sun to the center of gravity of the body. If Q denote the quantity of matter in the Sun, C the diſtance of its center from the center of gravity of the body, and q the quantity of matter in the body, the Sun and the body will mutually gravitate towards each other with a force, that is as $\frac{Qq}{C^2}$.

From

From the *Æther*'s preſſing upon bodies for cauſing gravity, in proportion to their quantities of matter; and from bodies, by their *vis inertiæ*, reſiſting a change of the ſtate they are in, whether of reſt or of motion, in proportion to their quantities of matter; it is evident, that the preſſure of the *Æther*, and the *vis inertiæ* of matter are proportional to one another.

Bodies do not change their ſtate of reſting or moving uniformly in a right line, but by the action of ſome impreſſed force exerciſed upon them, which force conſiſts in the action alone, and does not remain in the bodies after the action is over. For the bodies continue in their new ſtate, whether of reſting or of moving uniformly in a right line, by their *vis inertiæ* alone. The *vis inertiæ* of matter is a force neceſſary to make bodies reſiſt a change of their ſtate, whether of reſt or of motion, to make them receive motion in proportion to the force impreſſed, and to reſiſt as much as they are reſiſted.

That

That the *Æther* cauſes gravity, may appear from the following Queſtion in the Opticks.

" Is not this *Æther* (*for ſo he calls* " *the medium there mentioned*) much " rarer within the denſe bodies of the " Sun, Stars, Planets and Comets, than " in the empty celeſtial ſpaces between " them? And in paſſing from them to " great diſtances, doth it not grow den- " ſer and denſer perpetually, and thereby " cauſe the gravity of thoſe bodies " towards one another, and of their " parts towards the bodies; every body " endeavouring to go from the denſer " parts of the *Æther* towards the rarer? " For if this *Æther* be rarer with- " in the Sun's body than at its ſur- " face, and rarer there than at the hun- " dredth part of an inch from its body, " and rarer there than at the fiftieth part " of an inch from its body, and rarer " there than at the orb of *Saturn*; I ſee " no reaſon why the increaſe of den- " ſity ſhould ſtop any where, and not " rather be continued through all diſtan-

" ces

" ces from the Sun to *Saturn* and be-
" yond. And though this increaſe of
" denſity may at great diſtances be ex-
" ceeding ſlow, yet if the elaſtick power
" of the *Æther* be exceeding great, it
" may ſuffice to impel bodies from the
" denſer parts of the *Æther* towards the
" rarer with all that power which we
" call Gravity. And that the elaſtick
" force of the *Æther* is exceeding great,
" may be gathered from the ſwiftneſs of
" its vibrations." Sounds (cauſed by the vibrations of the Air) move 1142 *Engliſh* feet, or 0.2163 part of an *Engliſh* mile, in one ſecond minute of time. And *Light* moves from the Sun to the Earth in 8 minutes and 12 ſeconds, as that great Aſtronomer and Philoſopher, Dr. *Bradley*, has fully proved. But the diſtance of the Sun from the Earth is about 77889520 *Engliſh* miles, ſuppoſing the horizontal parallax of the Sun to be 10½ ſeconds. And therefore *Light* in moving from the Sun to the Earth deſcribes about 158312 *Engliſh* miles in one ſecond of time. And, of conſequence,

Light moves 731907 times ſwifter than Sound. The vibrations or pulſes of the *Æther*, that they may cauſe the alternate fits of eaſy tranſmiſſion and eaſy reflexion of *Light* muſt move ſwifter than *Light*, and, by conſequence, above 731907 times ſwifter than the vibrations or pulſes of the Air which cauſe Sounds. And therefore the elaſtic force of the *Æther*, in proportion to its denſity, muſt be above 731907 × 731907 (that is, above 535687856649) times greater, than the elaſtick force of the Air is in proportion to its denſity. For the ſquares of the velocities of the pulſes of elaſtick Fluids, are as the elaſticities of the Fluids in proportion to their denſities, or as the elaſticities and rarities of the Fluids taken together.

To compare the velocity of *Light* with other great velocities in nature, I have added the following table, which contains the names of the bodies in the firſt column; their velocities expreſſed in *Engliſh* miles and decimal parts deſcribed in one ſecond of time in the ſecond column; and in the third column $\frac{V}{v}$, is expreſſed

prefled the proportion of the velocity of *Light* denoted by V, to the velocity of any of the other bodies denoted by v; that is, the proportion of $\frac{158312.0337}{v}$ to 1. The velocities of the Planets are the velocities with which they move round their orbits. The velocity of a cannon-ball, when it leaves the gun, is ſuch as carries it about 1700 *Engliſh* feet, or the 0.3168th part of an *Engliſh* mile, in a ſecond, as has been proved by Mr. *Robins*, in his *New Principles of Gunnery.*

	Miles and decimal parts, deſcribed in 1″ of time by	$\frac{V}{v}$
Sound - - - - - - -	0.2163	731909
The Moon - - - -	0.3168	499722
A Canon-Ball - - -	0.3220	491652
Saturn - - - - - - -	5.0243	31509
Jupiter - - - - - -	6.8047	23265
Mars - - - - - - - -	12.5723	12592
The Earth - - - -	15.51867	10201
Venus - - - - - - -	18.2467	8676
Mercury - - - - -	24.9421	6347
The Rays of Light	158312.0337	

By

By this table it appears, that the velocity of *Light* moving from the Sun to the Earth, far exceeds all other known velocities in nature. From their immenſe velocity, the particles of *Light* muſt be exceedingly ſmall bodies; otherwiſe, their immenſe velocity would enable them to daſh all porous bodies which they ſtruck againſt to pieces; and they themſelves would be apt to be broke to pieces by the ſtroke, if they were not perfectly ſolid and void of pores.

The particles of *Light* are ſmall bodies of ſeven different ſizes, the leaſt of which particles, when ſeparated from the reſt, cauſe violet the weakeſt and darkeſt of the colours; and the reſt, as they are bigger and bigger, cauſe the ſtronger and more lucid colours, indigo, blue, green, yellow, orange and red. The leaſt of theſe particles of *Light* are moſt refrangible, and moſt eaſily turned out of their rectilineal courſe by refracting ſurfaces; and the reſt as they are bigger and bigger, are leſs and leſs refrangible, and more and more difficultly diverted from that courſe.

The thicknefs of plates or particles of bodies; which reflect the feven primary colours, are as the cube-roots of the fquares of the numbers $\frac{1}{2}$, $\frac{9}{16}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{8}{9}$, 1, whereby the times of a vibration, or the lengths of a mufical chord to found all the notes in an eighth are reprefented, that is, as the numbers 6300, 6814, 7114, 7631, 8255, 9243, 10000.

There is a remarkable analogy between the thickneffes of the plates or particles which reflect the feven primary colours, and the diftances of the primary planets from the Sun, which diftances are as the cube-roots of the fquares of the periodical times of the Planets. For the thickneffes of the plates or particles, anfwer to the diftances of the Planets from the Sun; and the times of a vibration, or the times of a mufical chord going forward and returning backward to the fame place, anfwer to the periodical times of the Planets.

It is proved in the Opticks, that *Light* is in fits of eafy reflexion and eafy tranfmiffion before its incidence on bodies; and the great Author thinks it very probable, that

that it is put into ſuch fits at its emiſſion from luminous bodies, and continues in them during all its progreſs. For he has ſhewn theſe fits to be of a laſting nature. Hence, we learn, that although the velocity of *Light* be rectilineal, yet it is not uniform, but is accelerated and retarded alternately through exceeding ſhort ſpaces, during its whole progreſs.

This accelerated and retarded motion of the Rays of *Light*, will put the *Æther* into a vibrating motion, when they impinge upon it at the ſurfaces of bodies. And when the *Æther* is thus put into a vibrating motion by the rays of *Light* falling upon it at the ſurfaces of bodies, its parts go forwards and backwards by turns, and they are condenſed in their progreſs, and rarified in their return. The vibrations of the *Æther* move ſwifter than the rays, from the *Æther*'s conſiſting of much ſmaller particles than the particles of *Light*; and therefore, if a ray with a retarded velocity fall upon the condenſed part of a vibration, it will be eaſily reflected; and the ſucceeding ray, by falling with an

an accelerated velocity upon the rarified part of the vibration, will be eaſily tranſmitted. And thus it is that a ray of *Light* is eaſily reflected or eaſily tranſmitted, as the vibrating motion of the *Æther* oppoſes or conſpires with its motion. This agrees with, and may in ſome meaſure illuſtrate the following accounts of the fits of eaſy reflexion and eaſy tranſmiſſion, given in the Opticks.

"As ſtones by falling upon water, put "the water into an undulating motion, and "all bodies by percuſſion excite vibra-"tions in the air; ſo the rays of *Light*, "by impinging on any refracting or re-"flecting ſurface, excite vibrations in the "*Æther*, and by exciting them, agitate "the ſolid parts of the refracting or re-"flecting body, and by agitating them, "cauſe the body to grow warm or hot; "the vibrations thus excited are propa-"gated in the *Æther*, much after the ſame "manner that vibrations are propagated "in the Air for cauſing Sound, and move "faſter than the Rays, ſo as to overtake "them; and when any ray is in that part of

" of the vibration which conſpires with " its motion, it eaſily breaks through a " refracting ſurface, but when it is in the " contrary part of the vibration which " impedes its motion, it is eaſily reflect- " ed; and, by conſequence, every ray is " ſucceſſively diſpoſed to be eaſily reflect- " ed, or eaſily tranſmitted, by every vi- " bration which overtakes it.

" Nothing more is requiſite for putting " the rays of *Light* into fits of eaſy re- " flexion and eaſy tranſmiſſion, than that " they be ſmall bodies, which by their " attractive powers, or ſome other force, " ſtir up vibrations in the *Æther*, which " vibrations being ſwifter than the rays, " overtake them ſucceſſively, and agitate " them, ſo as by turns to increaſe and " decreaſe their velocities, and thereby " put them into thoſe fits."

The lengths of the vibrations of the *Æther*, are equal to the intervals of the fits of eaſy reflexion and eaſy tranſmiſſion of *Light*. The vibrations are of different lengths, as they are excited by rays of different magnitudes. If the rays which paint the

the colour in the confine of yellow and orange pafs perpendicularly out of any medium into Air, the intervals of their fits of eafy reflexion are the $\frac{1}{89000}$th part of an inch. And of the fame length are the intervals of their fits of eafy tranfmiffion. And he has likewife proved that a red-making ray, in paffing through the middle of a globule of water the 500th part of an inch in diameter, has 250 fits of eafy tranfmiffion. And therefore the length of a vibration, or the interval of the fits in this cafe, is the $\frac{1}{125000}$th part of an inch.

I now proceed to confider the fecond force with which the *Æther* preffes upon bodies, for giving motion to their particles when they are very near to one another, and for making them cohere together when they touch. This force arifes from the mutual preffure of the *Æther* and *Light* on one another. For the *Æther* muft act with immenfe force on the particles of *Light*, to be able to throw them off from luminous bodies with that vaft velocity I have fhewn they have; and fince all action is mutual, the *Light* adhering to the

the ſurfaces of bodies will preſs equally on the *Æther* lying next to the ſurfaces, and make it to recede and grow denſer and denſer to a very ſmall diſtance from the ſurfaces of the bodies. The diſtance to which the condenſation of the *Æther* cauſed by this preſſure reaches, is extremely ſmall, and of a given length at the ſurface of the ſame body, from the unalterable nature of the particles of *Light*. But though the extent of this preſſure be very ſmall, too ſmall to be perceived by ſenſe, yet the increaſe of denſity through that very ſhort ſpace, is extremely great. The increment of the denſity, like the effects of all forces, propagated from any place conſidered as a center, leſſens as the ſquare of the diſtance from the ſurface of a body increaſes, and at the end of the given diſtance, which diſtance I ſhall call D, the whole increaſe of denſity in the *Æther*, will be as the increment of the denſity at the ſurface applied to the ſquare of D. But the increment of the denſity of the *Æther* at the ſurface, is as the quantity of *Light* adhering to the ſurface; which quantity in the

ſame body is as the denſity of the body; for all fixed and denſe bodies contain much *Light* in their compoſition; as appears from their emitting *Light*, when heated, ſo long as they continue ſufficiently hot; and from *Light*, emitted from the Sun and other luminous bodies, mutually ſtopping in bodies as often as its Rays ſtrike upon their parts; for there can be no reflexion of perfectly ſolid bodies ſtriking on one another. And therefore putting Δ for the denſity of the body, the whole increaſe of denſity cauſed by *Light* through the little narrow ſpace, whoſe breadth is expreſſed by D, will be as $\frac{\Delta}{D^2}$; or as Δ; D being given.

The breadth of the narrow ſpace through which the *Æther* was condenſed by the preſſure of the ſuperficial *Light*, in one caſe reached only to the 800th part of an inch from the ſurface of the body. And the rarefaction reached to an equal diſtance beyond the 800th part, that is, to the 400th part of an inch from the ſurface of the body.

The

The ſmall limits of theſe two ſtates of the *Æther*, whereby it cauſes attraction and repulſion in the ſmall particles of bodies, hinder theſe forces from diſturbing the force whereby the *Æther* cauſes gravity.

If the diameter of a ſmall globe of uniformly denſe matter, be equal to the diſtance to which the *Æther* is condenſed by *Light* adhering to its ſurface, that is, if the diameter be the 800th part of an inch, the force of gravity at the ſurface of the globe will be to the whole force of attraction, cauſed by *Light* adhering to the ſurface, as $D\Delta$, is to $\frac{\Delta}{D^2}$; or as D^3, is to 1, that is, as $\frac{1}{512000000}$, is to 1; or as 1, is to 512000000. If the force of gravity, at the ſurface of this globe, be 10000000000000000 times leſs than the force of attraction and repulſion cauſed by *Light* adhering to the ſurface, the diameter of the globe will be the $\frac{1}{1000000}$th part of an inch: And the diameter of the globe will be to the diſtance to which the attraction cauſed by

Light reaches, as $\frac{1}{100000}$ is to $\frac{1}{800}$, that is, as 1 is to 125.

Hence the motions caused by these forces in the small particles of bodies, are greater in smaller particles than in larger; and are often so strong in very small and dense particles of the last composition, as to make them meet and clash with the greatest force, so as to dash one another to pieces, and vanish into air, vapour and flame. And the same force that gives them motion, will cause them to cohere strongly when they are brought together, and touch; in case they be able to withstand the violence of the percussion.

The motion of a Ray of *Light* through the small space whose breadth is denoted by D, is an accelerated motion; and is of the same nature with the motion of a drop of oil of oranges, or spirit of turpentine, moving between two polished plates of glass, three or four inches broad, and twenty or twenty-five inches long, laid one of them parallel to the Horizon, and the other upon the first, so as at one of their ends to touch one another, and contain

tain an angle of 10 or 15 minutes; for the drop will move from the other end towards the concourſe of the glaſſes with an accelerated motion; and the whole increment of the denſity of the *Æther* at any diſtance from the concourſe of the glaſſes, to which increment the *vis motrix* of the drop is proportional, will be reciprocally as the ſquare of the diſtance of the middle of the drop from the concourſe of the glaſſes.

From this experiment, and others, of the aſcent of water up ſmall glaſs pipes, and up between parallel plates of glaſs placed near to one another, when the lower ends of the pipes, and lower edges of the plates are dipped into ſtagnating water: Sir *Iſaac* proceeds to explain the frame and conſtitution of bodies and their minute parts, in the following words.

" Now the ſmalleſt particles of matter
" may cohere by the ſtrongeſt attractions,
" and compoſe bigger particles of weaker
" virtue; and many of theſe may cohere
" and compoſe bigger particles whoſe vir-
" tue is ſtill weaker, and ſo on for divers
" ſucceſſions,

" ſucceſſions, until the progreſſion en[ds]
" in the biggeſt particles on which the
" operations in Chymiſtry, and the colours
" of natural bodies depend, and which
" by cohering compoſe bodies of a ſen-
" ſible magnitude. If the body is com-
" pact, and bends or yields inward to
" preſſion without any ſliding of its parts,
" it is hard and elaſtick, returning to its
" figure with a force ariſing from the
" mutual attraction of its parts. If the
" parts ſlide upon one another, the body
" is malleable or ſoft. If they ſlip eaſily,
" and are of a fit ſize to be agitated by
" heat, and the heat is big enough to
" keep them in agitation, the body is
" fluid; and if it be apt to ſtick to things,
" it is humid; and the drops of every
" fluid affect a round figure by the mu-
" tual attraction of their parts, as the
" globe of the Earth and Sea affects a
" round figure by the mutual attraction of
" its parts by gravity.

" Since metals diſſolved in acids attract
" but a ſmall quantity of the acid, their
" attractive force can reach but to a ſmall
" diſtance

" diſtance from them. And as in Alge-
" bra, where affirmative quantities vaniſh
" and ceaſe, there negative ones begin;
" ſo in mechanicks, where attraction cea-
" ſes, there a repulſive power ought to
" ſucceed. And that there is ſuch a vir-
" tue, ſeems to follow from the reflexions
" and inflexions of the Rays of *Light*.
" For the Rays are repelled by bodies in
" both caſes without the immediate con-
" tact of the reflecting or inflecting body.
" It ſeems alſo to follow from the emiſ-
" ſion of *Light*; the Ray ſo ſoon as it is
" ſhaken off from a ſhining body by the
" vibrating motion of the parts of the
" body, and gets beyond the reach of at-
" traction, being driven away with ex-
" ceeding great velocity. For that force
" which is ſufficient to turn it back in
" reflexion, may be ſufficient to emit it.
" It ſeems alſo to follow from the pro-
" duction of air and vapour. The par-
" ticles when they are ſhaken off from
" bodies by heat or fermentation, ſo ſoon
" as they are beyond the reach of the at-
" traction of the body, receding from it
" and

" and alſo from one another, with great
" ſtrength, and keeping at a diſtance, ſo
" as ſometimes to take up a million of
" times more ſpace than they did before
" in the form of a denſe body."

The firſt and leaſt of the compounded particles of which bodies are compoſed, are called *particles of the firſt compoſition*; the particles compounded of theſe, are called *particles of the ſecond compoſition*, and ſo on, till we come to the particles, on which the operations in Chymiſtry, and the colours of natural bodies depend, which are called *particles of the laſt compoſition*. The particles of the firſt compoſition are the denſeſt, and have the ſmalleſt pores; and thoſe of the laſt compoſition are the rareſt and have the largeſt pores. The *Æther* is rareſt in the ſmalleſt pores, and denſeſt in the largeſt pores. For the denſer the compounded particles are, the rarer is the *Æther* lodged within their pores, from the ſtronger action of the *Light* upon it, and the rarer the *Æther* in the pores of the particles is, the greater will be the increment of the denſity on the ſides oppo-

ſite

ſite to thoſe in which they touch, which will increaſe the ſtrength of their cohe-ſion.

As the increment of the denſity of the *Æther* at the ſurface of a body, cauſed by the preſſure of all the matter in the body upon it, cauſes gravity, and is the mea-ſure of that force; ſo the increment of the denſity of the *Æther* at the ſurface of the ſame body, cauſed by the preſſure of *Light* upon it, cauſes the force of coheſion and fermentation, and is the meaſure of that force.

HEAT in bodies conſiſts in a vibrating motion of their parts, which vibrating motion is cauſed by a vibrating motion of the *Æther* lodged within their pores. And the vibrating motion of the *Æther* lodged within the pores of bodies is excited by *Light*, the will of animals and other cau-ſes. But when the *Æther* within bodies is put into a vibrating motion by any cauſe, its elaſtick force is increaſed, from the *Æ-ther*'s being denſer in the pulſes of its vi-brations, than it is in a quieſcent ſtate. But an increaſe of the elaſtick force of the *Æ-*

E *ther*

ther within the pores of a body, will necessarily press its parts outwards and enlarge the dimensions of the body; and the rarefaction, or enlargement of the body, will be proportional to the increase of the elastick force of the *Æther* within its pores; that is, to the strength and vigour of its vibrating motion. And therefore, the degree of heat in a body, which consists in a vibrating motion of its parts, will be measured by the degree of rarefaction or enlargement of the body, which may be known by a Thermometer.

Various have been the Thermometers used for this purpose; an account of which is given by Doctor *George Martine* in his *Essays Medical and Philosophical.* The Thermometer at present mostly used is the mercurial one of *Fahrenheit*, in which the freezing point is placed at 32 degrees above the ball, and the external heat of a human body at 96. Sir *Isaac Newton* begins his scale of the degrees of heat, from the heat of the air in winter when water begins to freeze; and at this degree of heat he places 0.

Sir *Iſaac Newton* lived in *London,* when his *Scala graduum Caloris* was publiſhed in the Philoſophical Tranſactions in the year 1700. Nº 270. And the following tranſlation of that accurate ſcale, was publiſhed in Mr. *Cotes's* lectures by the learned Dr. *Smith* in the year 1738.

A ſcale of degrees of heat by Sir Isaac Newton.

The deſcriptions and ſigns of heats.

0.	THE heat of air in winter, when water begins to freeze. This heat may be exactly determined by placing a thermometer in compreſſed ſnow when it begins to thaw.
0,1,2	The heats of the air in winter.
2,3,4	The heats of the air in ſpring and autumn.
4,5,6	The heats of the air in ſummer.

6		The heat of the air at noon about the month of July.
12		The greateſt heat which a thermometer can acquire in contact with a human body: the heat of a bird hatching her eggs is much the ſame.
$14\frac{3}{11}$	$1\frac{1}{4}$	Almoſt the greateſt heat of a bath that a perſon can bear while his hand is immerſed and conſtantly agitated for ſome time. The heat of the blood juſt let out of the body is almoſt the ſame.
17	$1\frac{1}{2}$	The greateſt heat of a bath that a perſon can bear, while his hand is immerſed and kept conſtantly at reſt for ſome time.
$20\frac{2}{12}$	$1\frac{3}{4}$	The heat of a bath in which floating wax, after it has been melted, begins by cooling to loſe its fluidity and tranſparency.
24	2	The heat of a bath, by which floating wax is ſo heated as to melt, and continue in fuſion without ebullition.

A mid-

$28\frac{6}{11}$	$2\frac{1}{4}$	A middle degree of heat between that wherewith wax melts and water boils.
34	$2\frac{1}{2}$	The heat with which water boils vehemently, and a mixture of 2 parts of lead, 3 of tin and 5 of biſmuth grows ſtiff by cooling. Water begins to boil with a heat of 33 parts, and in boiling ſcarce ever exceeds a heat of $34\frac{1}{2}$. Drops of hot water falling upon hot iron, ceaſe to bubble, when the iron has 35 or 36 parts of heat, and of cold water, when the iron has 37 parts.
$40\frac{4}{11}$	$2\frac{3}{4}$	The leaſt heat with which a mixture of 1 part of lead, 4 of tin and 5 of biſmuth, will melt and continue in fuſion.
48	3	The leaſt heat with which a mixture of equal parts of tin and biſmuth melts. This mixture by cooling grows ſtiff with 47 parts of heat.
57	$3\frac{3}{4}$	The heat with which a mixture of 2 parts of tin and 1 part of

		of bismuth melts; as also a mixture of 3 parts of tin and 2 of lead: but a mixture of 5 parts of tin and 2 parts of bismuth, grows stiff by cooling in this heat; and so does a mixture of equal parts of tin and bismuth.
68	$3\frac{1}{2}$	The least heat with which a mixture of 1 part of bismuth and 8 parts of tin melts. Tin by itself melts with a heat of 72 parts, and grows stiff by cooling in a heat of 70 parts.
81	$3\frac{1}{4}$	The heat with which bismuth melts, as also a mixture of 4 parts of lead and 1 part of tin. But a mixture of 5 parts of lead and 1 part of tin, after it has been melted, grows stiff by cooling in this heat.
96	4	The least heat with which lead melts. It grows hotter and melts with a heat of 96 or 97 parts, and grows stiff by cooling in a heat of 95 parts.

The

114 | $4\frac{1}{4}$ | The heat with which burning bodies by cooling ceaſe to be viſible in a dark night, and on the contrary by heating begin to ſhine in the ſame degree of darkneſs, but with ſo faint a light as is ſcarce ſenſible. With this heat a mixture of equal parts of tin and regulus martis, and alſo a mixture of 7 parts of biſmuth and 4 parts of that regulus, grows ſtiff in cooling.

136 | $4\frac{1}{2}$ | The heat with which burning bodies ſhine in a dark night but not at all in the twilight. With this heat a mixture of 2 parts of regulis martis and 1 part of biſmuth, and alſo a mixture of 5 parts of regulus martis and 1 part of tin, grow ſtiff by cooling. Regulus alone grows ſtiff with a heat of 146 parts.

161 | $4\frac{3}{4}$ | The heat wherewith bodies burning in the twilight, juſt before ſun-riſe or after ſun-ſet, ſhine manifeſtly, but not at all

		or but very obſcurely in broad daylight.
192	5	The heat of burning coals in a ſmall fire made of bituminous pit-coal, and not blown with the bellows. Iron heated as hot as poſſible in this fire, has the ſame heat as the fire itſelf. But the heat of a ſmall fire made of wood, is a little greater, having 200 or 210 parts; and the heat of a large fire is ſtill greater, eſpecially if blown with bellows.

In the firſt column of this table we have degrees of heats in arithmetical progreſſion, beginning from the heat with which water juſt begins to freeze, as the loweſt degree of heat, or as a limit common to heat and cold, and conſidering the external heat of a human body as conſiſting of 12 equal parts.

In the ſecond column we have degrees of heats in geometrical progreſſion; the firſt degree (12) is the external heat of a human body adjuſted by our ſenſes, the ſecond (24) is double the firſt, the third (48) is

is double the ſecond, the fourth (96) is double the third and the fifth (192) double the fourth *(a)*.

By this table it appears, that the heat (34) of boiling water, is almoſt three times greater than the heat (12) of a human body, and the heat (72) of melting tin ſix times greater, and the heat (96) of melting lead eight times greater, and the heat (146) of melting regulus about twelve times greater, and the heat (200) of a common fire about ſixteen or ſeventeen times greater than the heat of a human body.

The table was conſtructed by the help of a thermometer and red-hot iron. By

(a) I underſtand the Author's ſenſe of this paragraph as follows. "In the ſecond column we have" a ſcale of "indices or exponents of "degrees of heat in geometrical progreſſion." The numbers 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2, &c. in the ſecond column, being in arithmetical progreſſion, are a ſcale of logarithms, or meaſures of the ratio's of the heats expreſſed by the correſponding numbers 12, $14\frac{3}{11}$, 17, $20\frac{2}{11}$, 24, &c. in the firſt column; which being in geometrical progreſſion, may be ſoon found by taking $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of the logarithm of 2, or of the ratio of 1 to 2, and multiplying the correſponding abſolute numbers, in the table of logarithms, by 12. Then by doubling the 4 laſt terms of the geometrical progreſſion ſo found, you get the 4 next, and by doubling theſe you have the 4 next, and ſo on to the end of the ſcale.

the thermometer I found the meaſures of all the heats as far as that which melts tin, and the meaſures of all the reſt by red-hot iron. For the heat which the iron communicates to contiguous cold bodies in a given time, that is, the heat which it loſes in a given time, is as the whole heat of the iron. Conſequently if the time of its cooling be divided into any equal parts, the correſponding heats [both loſt and retained] will decreaſe in a geometrical progreſſion, and therefore may eaſily be found by a table of logarithms *(b)*.

Firſt then by a thermometer made with linſeed-oil, I found when the thermometer was placed in melting ſnow, if the oil took up 10000 equal parts of ſpace, that the ſame oil, being afterwards rarefied and dilated by the firſt degree of heat, or that of a human body, took up 10256 ſuch parts, and by the heat of water juſt beginning to boil 10705 parts, and by the heat of water boiling vehemently 10725

(b) When any ſet of quantities are to each other reſpectively as their differences, then as well the quantities themſelves, as their differences, are in geometrick progreſſion. If $a : a-b :: b . b-c :: c : c-d$ &c. then converſely $a : b :: b : c :: c : d$ &c.

parts,

parts, and by the heat of melted tin, when by cooling it began to ſtiffen to the conſiſtence of an amalgama 11516 parts, and when quite ſtiff 11496 parts.

Therefore the oil was rarefied and dilated in the ratio of 40 to 39 by the heat of a human body, in the ratio of 15 to 14 by the heat of boiling water, in the ratio of 15 to 13 by the heat of melted tin beginning to ſtiffen and coagulate by cooling, and in the ratio of 23 to 20 by the heat of tin juſt grown quite ſtiff.

The rarefaction of the air by an equal heat was ten times greater than that of the oil, and the rarefaction of the oil about fifteen (*c*) times greater than that of ſpirit of wine.

(*c*) The original runs thus, *Rarefactio aeris æquali calore fuit decuplo major quam rarefactio olei, & rarefactio olei quaſi quindecim vicibus major quam rarefactio ſpiritus vini*, in which I conceive there is ſome miſtake. For Dr. *Halley*, by an experiment deſcribed in the Philoſ. Tranſact. N° 197. found that when ſpirit of wine began to boil (after which it has no regular expanſion) it had increaſed itſelf a 12th part of its bulk when cold in winter time; and by my own trial I have found, that with the heat of ſpirit of wine beginning to boil, the linſeed oil in my thermometer had increaſed itſelf about 53 thouſandth parts of its bulk when placed in thawing ſnow, or to make a juſter compariſon, about $\frac{51}{1002}$ parts of its bulk when cold in winter time. Therefore the increment of the ſpirit, is to that of the oil, produced by equal heats, as $\frac{1}{12}$ to $\frac{51}{1002}$ or 501 to 306, or about 5 to 3.

By theſe experiments, taking the heats of the oil to be proportional to its rarefaction (*d*), and for the external heat of a human body writing 12 parts, the heat of water juſt beginning to boil, comes out 33 ſuch parts, and of water boiling vehemently 34 parts, and of tin either beginning to melt or to ſtiffen into an amalgama 72 parts, and of tin juſt become quite ſtiff and hard 70 parts.

Having found theſe heats, in order to determine the reſt, I heated a piece of iron of a ſufficient thickneſs, till it became red-hot, and taking it from the fire with the tongs likewiſe red-hot, I immediately put it in a cool place where the wind blew conſtantly, and upon it I laid particles of diverſe metals and other fuſible bodies, and noted the ſeveral inſtants of time when by cooling they loſt their fluidity and began to coagulate, and laſtly when the heat of the iron became equal to the external heat of a human body.

(*d*) That is, to the increment of its bulk, as appears by the numbers in the two laſt paragraphs but one.

Then

Then upon this principle, that the exceſſes of the heats of the iron and coagulating particles, above the heat of the atmoſphere, found by my thermometer, were in a geometrical progreſſion, when the times were taken in an arithmetical progreſſion, I determined all thoſe heats.

I placed the iron not in a ſtagnating air, but in a wind blowing uniformly, that the air heated by the iron might immediately be driven away by the wind, and that cool air might continually ſucceed it with an uniform motion. For by this means equal parts of the atmoſphere were heated in equal times, with degrees of heat proportionable to the heats of the iron.

Now the heats ſo determined were to one another in the ſame ratio's as the heats found by my thermometer, and therefore the principle I aſſumed, that the heats of the oil were proportionable to its rarefaction, is a true principle *(e)*.

(e) This property of the rarefaction of linſeed oil was afterwards confirmed by an experiment made by Dr. *Brook Taylor*, and deſcribed in the Philoſoph. Tranſact. Nº 376.

TABLE

TABLES of HEAT.

TABLE I.

Dublin in Ireland.	1745	1746	1747	1748	1749	1750	Mean of 6 Years.
November	1.80	1.26	2.21	1.89	1.75	1.47	1.73
December	1.26	1.39	0.63	1.89	0.72	2.03	1.32
January -	1.51	1.42	0.95	1.26	1.52	1.24	1.32
February	2.15	1.39	0.63	1.58	2.53	1.62	1.63
March - -	1.77	1.89	1.58	1.58	2.39	2.35	1.93
April - -	2.81	3.44	2.21	2.84	2.98	2.83	2.85
May - -	4.77	4.10	3.79	3.79	4.40	3.89	4.12
June - -	4.33	4.77	5.05	4.42	5.27	4.78	4.74
July - - -	5.05	5.37	4.77	5.05	5.76	5.24	5.21
Auguſt -	4.77	5.68	4.77	4.42	5.10	4.94	4.[illegible]1
September	3.79	3.44	4.10	2.84	4.83	3.78	4.13
October -	2.21	3.16	2.8[illegible]	2.21	2.28	2.77	2.58
Mean - -	3.00	3.12	2.78	2.81	3.29	3.08	3.01
Winter - -	1.51	1.36	1.26	1.67	1.33	1.58	1.45
Spring - -	2.24	2.24	1.45	2.00	2.63	2.27	2.14
Summer -	4.62	4.77	4.51	4.42	5.14	4.64	4.68
Autumn -	3.75	4.10	3.88	3.16	4.07	3.83	3.80
Mean - -	3.00	3.12	2.78	2.81	3.29	3.08	3.0[illegible]

TABLE

TABLE II.

Edinburgh in Scotland.	1731	1732	1733	1734	1735	Mean of 5 Years.
November	1.37	0.96	2.23	0.96	3.34	1.78
December	0.68	0.77	2.14	0.77	2.83	1.44
January -	0.51	1.20	0.51	0.85	3.00	1.22
February	1,88	1.45	1.97	0.68	1.80	1.56
March -	1.88	1.45	2.48	1.45	5.57	2.57
April - -	2.34	2.91	3.43	2.57	5.40	3.35
May - -	3.43	3.85	3.34	3.34	5.74	3.94
June - -	4.28	5.05	5.14	4.80	6.25	5.10
July - -	5.14	4.88	5.31	5.05	6.68	5.45
Auguſt -	4.54	4.37	4.28	4.37	7.54	5.01
September	4.03	3.43	3.43	3.25	5.31	3.89
October -	3.00	2.48	2.31	1.80	3.85	2.69
Mean - -	2.74	2.74	3.05	2.49	4.77	3.16
Winter -	0.85	0.94	1.63	0.86	3.06	1.47
Spring -	1.99	1.94	2.63	1.53	4.26	2.47
Summer -	4.28	4.56	4.59	4.39	6.23	4.83
Autumn -	3.86	3.43	3.34	3.14	5.57	3.87
Mean - -	2.74	2.74	3.05	2.48	4.78	3.16

TABLE

TABLE III.

Charles-town in South-Carolina.	1738	1739	1740	1742	Mean of 4 Years.
November - -	4.03	3.28	3.28	3.19	3.44
December -	2.91	3.37	2.44	3.65	3.09
January - -	4.03	2.25	3.09	3.56	3.24
February -	3.94	4.59	3.56	2.72	3.70
March - -	3.94	5.15	4.69	4.22	4.37
April - - -	6.75	6.56	6.56	7.78	6.91
May - - -	7.40	7.89	7.40	8.15	7.71
June - - -	8.72	8.62	8.62	8.53	8.61
July - - - -	9.09	8.72	9.09	9.75	9.16
August - -	8.34	7.78	8.72	9.19	8.51
September -	7.60	7.78	7.12	6.06	7.15
October - -	4.78	5.44	4.12	5.25	4.90
Mean - - -	5.95	5.94	5.71	6.00	5.90
Winter - -	3.66	2.97	3.94	3.47	3.26
Spring - -	4.88	5.44	4.94	4.91	4.99
Summer - -	8.40	8.40	8.37	8.81	8.49
Autumn - -	6.91	7.00	6.65	6.84	6.85
Mean - - -	5.95	5.94	5.71	6.00	5.90

TABLE IV.

The Island of Minorca.	1744	1745	1746	1747	1748	1749	Mean of 4 Years.
November	4.50	4.91	4.80	5.26	4.93		4.97
December	3.36	3.99	4.50	4.99	4.76		4.56
January -		3.75	3.88	3.77	3.66	4.33	3.76
February		4.12	3.67	4.26	4.31		4.09
March - -		5.06	4.15	4.23	4.37		4.45
April - -		5.43	5.57	5.57	5.53	5.77	5.52
May - -		6.42	6.77	7.31	6.80	6.84	6.82
June - -		7.78	7.76	8.25	8.23	7.91	8.00
July - - -	8.36	8.51	9.15	8.85	8.84	9.41	8.85
August -	8.45	8.59	8.34	9.02	8.83		8.69
September	7.70	7.95	6.60	7.63	7.82		7.50
October -	6.79	6.30	5.00	6.32	6.25		5.97
Mean - -	6.52	6.07	5.85	6.29	6.19		6.12
Winter - -		4.22	4.39	4.67	4.45		4.43
Spring - -		4.87	4.46	4.69	4.74		4.69
Summer -		7.57	7.89	8.14	7.96	8.05	7.89
Autumn -	7.65	7.61	6.65	7.65	7.63		7.39
Mean - -		6.07	5.85	6.29	6.19		6.10

TABLE V.

Heat of the Weather at Kingston in Jamaica, for four months, in the year 1747.	Morn.	Noon.	Even.
April - - - - - - - - - - - - - -	8.59	9.55	9.15
May - - - - - - - - - - - - - - -	8.63	9.68	9.20
June - - - - - - - - - - - - - - -	9.01	10.02	9.37
July - - - - - - - - - - - - - - -	9.10	10.08	9.53
Mean - - - - - - - - - - - - - -	8.83	9.83	9.31
Mean Heat in Summer - - - -	8.91	9.93	9.37

TABLE VI.

Seaſons.	London in England.	Dublin in Ireland.	Edingburgh in Scotland.	Charles-town in South-Carolina.	The Iſland of Minorca.	Kingſton in Jamaica.
	Mean by Sir *Iſaac Newton*	Mean of 6 Years.	Mean of 5 Years.	Mean of 4 Years.	Mean of 4 Years.	Mean of 3 Months
Winter - -	1.00	1.45	1.47	3.26	4.43	
Spring - -	3.00	2,14	2.47	4.99	4.69	
Summer -	5.00	4.68	4.83	8.49	7.89	9.40
Autumn -	3.00	3.80	3.87	6.85	7.39	
Mean - -	3.00	3.01	3.16	5.90	6,10	

TABLE VII.

The mean Heats of the Seasons, Spring, Summer, and Autumn, with respect to the mean Heat in Winter, considered as 1, or as 1.00, in several Places.

Places.	Winter.	Spring.	Summer.	Autumn.
London - - - -	1.00	3.00	5.00	3.00
Dublin - - - - -	1.00	1.47	3.23	2.62
Edinburgh - - -	1.00	1.68	3.29	2.63
Charles-town - -	1.00	1.53	2.60	2.10
Minorca - - - -	1.00	1.06	1.78	1.67

TABLE

TABLE VIII.

The Degrees of HEAT, by Dr. *Martine.*	*Newton's* Scale.	
When ſome cold Animals begin to freeze	5.250	Below the freezing point.
Lambs Blood begins to freeze - -	1.313	
Milk - - - - - - - - - - - - - - -	0.370	
Urine - - - - - - - - - - - - - - -	0.750	
Water - - - - - - - - - - - - - - -	0.000	
Of Flounders, Whitings, Cod-fiſh, Haddocks, Trouts, Carp, Eels, *&c.* is 0.188 of a degree warmer than the Water they ſwim in - - - - - - - - - - - - - - -		Above the freezing point.
Of Snails is 0.375 of a degree warmer than the Air they live in - - - - - - -		
Of Frogs and Land-Tortoiſes, is 0.937 of a Degree warmer than the Air they breath in - - - - - - - - - - - - - - -		
Of Sea-Tortoiſes, Toads, Vipers, and all the Serpent-kind, when ſheltered in Winter, about - - - - - - - -	3.000	
Of Dogs, Cats, Oxen, Sheep, and Cetaceous Fiſhes - - - - - - - - - - - - - -	12.937	
Of Ducks, Geeſe, Pigeons, Partridges, Swallows, *&c.* - - - - - - - - - - - - - -	13.687	
Of the Serum and white of an Egg beginning to coagulate - - - - - - - - -	23.250	
Of boiling Alcohol - - - - - - - - - - - -	26.625	
Water - - - - - - - - - - - - -	33.750	
Pickle ſtrong - - - - - - -	34.875	
Lixivium of pot-aſhes - -	39.000	
Spirit of Nitre - - - - - - -	39.375	
Vitriol - - - - - - -	96.375	
Oil of Turpent. and diſtil. Oils	99.000	
Quickſilver and expreſſed Oils	106.500	

Ob-

Obſervations on the foregoing Tables.

1. When a thermometer is truly conſtructed, the heats of bodies may be found by it, for they will be as the heights of the oil or mercury above its freezing point expreſſed in the parts of its ſcale: for inſtance, if the heights of the oil or mercury above the freezing point, be 18 and 37 parts of the ſcale of the thermometer, the two degrees of heat by which the oil or mercury is rarefied will be as thoſe numbers, and might be truly expreſſed by them, if the ſcales of all thermometers were ſo divided, as to expreſs the ſame degrees of heat by the ſame numbers; but as they are generally divided otherwiſe, in order to do this, they muſt all be reduced to ſome one ſcale as a ſtandard, and no one ſo proper for a STANDARD, as Sir *Iſaac Newton*'s. All ſcales may be reduced to this, by the following analogy. *As the number of parts of the ſcale of any thermometer which meaſures the external heat of a human body, is to the number of parts of the ſame ſcale which meaſures*

meaſures any other degree of heat; ſo is 12 *the number in Sir* Iſaac's *ſcale expreſſing the external heat of the body, to a fourth number, which will expreſs that other degree of heat according to his ſcale.* If the numbers meaſuring the two degrees of heat be 30 and 15 parts of the ſcale of the thermometer, the correſponding numbers of Sir *Iſaac*'s ſcale will be 12 and 6, which are the numbers meaſuring the external heat of the body, and the heat of the *Meridian* Air about the month of *July*. If H denote the Heat in *Fahrenheit*'s thermometer, expreſſed by the numbers to which the oil or mercury riſes above the freezing point; Then will $\frac{3H}{16}$ reduce the numbers expreſſing the heats in *Fahrenheit*'s ſcale, to the numbers expreſſing the ſame degrees of heat in *Newton*'s ſcale. And the theorem for reducing the heats, expreſſed in the *Edinburgh* thermometer, to the ſame heats in *Newton*'s ſcale, will be expreſſed by $\frac{6H}{7}$.

2. By theſe Tables, the heat of the Air in Autumn, is greater than the heat of the

Air

Air in Spring, January is generally the coldeſt and July the hotteſt month in the whole year, as appears from the four firſt Tables. I have been aſſured by a knowing butcher, that animals have leaſt bile in January, and moſt in July. And if this be the caſe, as I believe it generally is, then heat generates bile, and cold generates pituita or phlegm. Which agrees with the obſervations of *Hippocrates*, who ſays, that all diſeaſes ariſe from bile and phlegm; and that changes of the ſeaſons of the year, eſpecially great changes of heat and cold, and of other things in proportion, are the principal cauſes of diſeaſes.

3. Heat promotes fluidity very much, by leſſening the tenacity of bodies. It makes many bodies fluid, which are not fluid in cold, and increaſes the fluidity of tenacious liquids, as of oil, balſam, honey, mucilages, and a ſtrong ſolution of ſoap in water. Heat attenuates the blood, volatilizes its ſalt, earth and oil, and thereby renders it more bilious and acrid; and cold has a contrary effect on the blood, as may appear by comparing the ſymp-

toms of the fever mentioned by Tabor, *(f)* with the ſymptoms of fevers in hot countries.

Mr. *Clegborn*, in his Obſervations on the epidemical Diſeaſes of *Minorca*, has given a very particular account of the diſeaſes in that iſland.

" In the bodies of near 100 perſons, " who died of tertian fevers in *Minorca*, " were conſtantly found one or other of " the adipoſe parts of the lower belly " (the caul, meſentery, colon, *&c.)* of a " dark black colour, or totally corrupted; " the gall-bladder full and turgid, and " the ſtomach and inteſtines overflowing " with bilious matter; the ſpleen large, " ſometimes weighing 4 or 5 pounds, and " ſo exceſſively ſoft and rotten, that it had " more the appearance of congealed blood " wrapped up in a membrane, than of " an organical part. In the cavities of " the head and breaſt, nothing extraordi- " nary was met with, excepting yellow " ſerum, when the ſkin was tinged with " the ſame colour."

(f) Exercitationes Medicæ, p. 77.

On enquiring into the nature of the cold fit in *Minorca*, he gave me the following account. " The cold fit is not fo " conftant an attendant of intermittents " in *Minorca*, as in colder climates. I " have frequently met with intermittents, " and thofe of the worft kind, where the " paroxyfms began without any perceiv- " able cold. But for the moft part, the " firft paroxyfms were ufhered in by a " cold fit, which became fhorter and fhor- " ter in the fubfequent paroxyfms. For " example, in the firft fit of the fever, " the coldnefs often lafts two hours, in " the fecond fit, an hour and a half or an " hour, in the third, it is lefs perceivable, " and continues a fhorter time, and in the " fourth, there is often no cold fit."

4. In Table IV. which I took from a table of his, expreffing the degrees of heat in his Table in the numbers of *Newton*'s fcale, it is obfervable, that the Spring heat is very little greater than the Winter. And the reafon of the coldnefs of the Spring, he fays, is the frequency of northerly winds in that feafon.

Table

5. Table V. was made from four months obſervations at *Kingſton* in *Jamaica*, from the beginning of April to the end of July, by a gentleman, who, though no phyſician, gives the following account of their diſeaſes. " The fever which terminates " in ſix or ſeven days ſeizes, generally " ſpeaking, without any previous com- " plaints, beſides a pain in the back or " head, or both, and ſometimes a vomit- " ing, and ſometimes ſo ſhort a chilneſs, " that from their being very well, to their " being very ill, is not above three or four " hours. For three of the firſt days they " are languid, with a low quick pulſe, " and inward heat and thirſt. By the " fourth day, if a yellowneſs appears a- " bout the eyes, with a hickup, raving, " and inſenſibility of danger, they com- " monly die about the ſixth or ſeventh " day. Under theſe circumſtances, for " three or four of the laſt days, the out- " ward heat and raving increaſe, and for " two or three of the laſt days, they " ſcarcely keep any thing in their ſto- " machs. The urine is fiery red, the

" tongue white, and sometimes a critical " yellowness appears in the skin about the " fourth day, with an abatement of the " symptoms. And if this, or a large sweat " happens at any time to the sixth or the " seventh day with relief, the patient is " commonly out of danger.

" There is another kind of fever of the " inflammatory kind, which is sometimes " relieved by the common evacuations " and regimen, or else it terminates in an " intermitting fever, which is cured by " the bark.

" Chronical disorders are not common " there, and are commonly owing to the " patient's irregularity during the returns " of his intermitting fever.

" After repeated attacks of the inter- " mitting fever, they have sometimes " what they call a dry belly-ach, which " is sometimes owing to cold before they " are quite recovered. This disorder was " formerly more common amongst the " lower sort of people, when they drank " spirits more freely; and it often termi- " nated in a loss of their limbs.

" They

" They generally have breezes from the
" ſea, which they reckon wholeſome.

" About November they have north
" winds, which continue to blow for
" three months, during which time the
" intermitting fevers are moſt frequent,
" as they likewiſe are after great rains,
" which generally fall heavieſt and laſt
" longeſt in the months of May, Auguſt
" and October."

6. By comparing the Tables of *Edinburgh* and *Dublin*, it appears that the degrees of heat in the ſeveral ſeaſons of the year are much the ſame in both cities, only the Spring heat is ſomething greater in *Edinburgh* than it is in *Dublin*.

7. By Table VII. it appears, that the heats of Spring, Summer, and Autumn, with reſpect to the Winter heat, are greater in cold climates, than in hot climates.

To theſe Obſervations on the Tables, may be joined what *Towne*, in his *Treatiſe of the Diſeaſes of the* Weſt-Indies, calls, the *Febris ardens климатиоſa*, the moſt endemial fever in thoſe parts, which he thus deſcribes.

" This

" This fever invades the patient in a
" most precipite manner. The only no-
" tice it gives of its assault is a momen-
" tary chillness and shivering, which
" is soon succeeded by a burning heat,
" which disperses itself universally over the
" body, but is felt more intensely about
" the *Præcordia*. This heat is attended
" with a high, strong and rapid pulse,
" heaviness in the eyes, a throbbing pain
" in the head, and violent beating of the
" temporal arteries, a thick and laborious
" respiration, nauseousness and reaching
" to vomit, and when any thing is thrown
" up, it is of the bilious kind; to these
" we may add great anxiety, pain in the
" back and loins, and an uneasy lassitude
" in all the limbs.

" The *symptoms* subsequent to these
" (which often discover themselves in the
" space of twelve hours from the invasi-
" on) are a dry, harsh, rough and disco-
" loured tongue, insatiable thirst, soreness
" all over the body, great restlesness and
" deliria.

" In

" In the laſt *ſtage*, the patient labours un-
" der a deep coma, oppreſſion of the *Præ-*
" *cordia*; heaving of the lungs, trem-
" bling of the tendons; convulſions and
" cold clammy ſweats.

" Theſe are the three advances to be
" taken notice of in this fever, which uſu-
" ally terminates in a favourable *criſis*, or
" death of the patient, about the fourth
" day of the attack."

And if we farther add what Dr. *Wintringham* has ſaid concerning the epidemick diſeaſes and changes of the air in and about the city of *York*, for ſixteen years together; and likewiſe what *Tabor* has ſaid concerning the fever deſcribed p. 77, 78; we may be able to judge of the extraordinary effects of heat and cold on the blood and fibres of human bodies.

The Phænomena of *muſcular motion* are theſe. When a muſcle is moved by the power of the will of animals, its fleſhy part is ſhortened in length, and ſwelled in thickneſs; and theſe motions of the fleſhy part, as to ſtrength and duration, entirely depend on the power of the will. The motions

are

are quick and ſtrong, or ſlow and weak, according to the ſtrength or weakneſs of the power of the will exciting theſe motions; and the motions continue no longer than the power of the will is exerciſed; they ceaſe preſently on a ceſſation of the action of that power. The will loſeth its power of moving the muſcles, when their nerves are cut quite through or tied ſtraight. The nerves are diſperſed throughout the fleſhy part of a muſcle, as appears from the pain that is cauſed by pricking any part of it with the fineſt needle. The fleſhy part of a muſcle is plentifully ſtocked with blood-veſſels, as appears from its redneſs, from blood iſſuing out of a wound made in it by the ſmalleſt needle, and likewiſe from the fleſh of a muſcle growing white when all the blood is waſhed out of it. By opening animals alive, it has been obſerved, that the fleſhy fibres grow pale during their action, and turn red again when at reſt. It has likewiſe been obſerved, if the muſcles of the arm be contracted by the power of the will, while blood is flowing out of an orifice

made

made in one of its veins, that the force of the contraction at firft accelerates the motion of the blood through the orifice, but foon retards and ftops it, if the mufcles be kept in that contracted ftate for any time. The contraction of the mufcles is very violent in ftrong convulfions, fo very violent that bones have been faid to be broken by this motion.

Thefe are the principal Phænomena of *mufcular motion*, and they are all caufed by the vibrations of the *Æther*, excited in the brain by the power of the will, and propagated from thence through the folid, pellucid and uniform capillamenta of the nerves into the mufcles. For when the *Æther* is put into a vibrating motion, its elaftick force is increafed, and an increafe of this force in a mufcle, fwells the thicknefs, and contracts the length of its flefhy part, as I have proved in the *Animal Oeconomy*, and in the *Differtation on the Æther*. As Sir *Ifaac Newton*, in the paragraph I have quoted, pofitively afferts all fenfation and mufcular motion to be caufed by the vibrations of the *Æther*, fo the

23d and 24th queſtions may be changed into poſitive aſſertions, and ſtand thus.

"Viſion is performed chiefly by the "vibrations of the *Æther*, excited in "the bottom of the eye by the Rays of "*Light*, and propagated through the ſo- "lid, pellucid and uniform capillamenta "of the optick nerves into the place of "ſenſation. And hearing is performed "by the vibrations of the *Æther*, excit- "ed in the auditory nerves by the tremors "of the Air, and propagated through the "ſolid, pellucid and uniform capillamen- "ta of thoſe nerves into the place of ſen- "ſation. And ſo of the other ſenſes.

"Animal motion is performed by the "vibrations of the *Æther*, excited in the "brain by the power of the will, and pro- "pagated from thence through the ſolid, "pellucid and uniform capillamenta of "the nerves into the muſcles, for con- "tracting and dilating them. I ſuppoſe "that the capillamenta of the nerves are "each of them ſolid and uniform, that "the vibrating motion of the *Æther* may "be propagated along them from one end

"to

"to the other uniformly, and without "interruption: for obſtructions in the "nerves create palſies. And that they "may be ſufficiently uniform, I ſuppoſe "them to be pellucid when viewed ſingly, though the reflexions in their cylindrical ſurfaces may make the whole "nerves (compoſed of many capillamenta) appear opaque andwhite. For opacity ariſes from reflecting ſurfaces, ſuch "as may diſturb and interrupt the motions of the *Æther*."

By the anſwer he gave to Doctor *Helſham*, who aſked him, how muſcular motion is performed by the vibrations of the *Æther*, it appears that he excluded all animal fluids, and conſequently animal ſpirits, ſecerned by the nerves from the blood in the brain, from having any ſhare in cauſing this motion. The anſwer was this, "I ſuppoſe, ſaid he, the vibrations of the *Æther* propagated from the brain through "the nerves to the muſcles to agitate their "membranes, and to ſwell them without "heat; and that the fluids are not concerned in cauſing this motion, nor un-

"dergo any other change, than what ari-
"ses from a change made in their veſſels
"by the motion of the membranes."

The changes made in the blood-veſſels by the ſwelling and contracting of the membranes, and the changes made in the motion of the blood by the changes made in the blood-veſſels, may be known from the following obſervations.

1. *By opening animals alive, and alſo in great wounds, the fleſhy fibres have been diſcovered to grow pale during their action, and to turn red again when at reſt.* Hence we learn that muſcles empty themſelves of blood when they contract, and fill with blood, when they dilate: And therefore all muſcles, the heart and all others, act on the blood in much the ſame manner.

2. *It has been obſerved, if the muſcles of the arm be ſtrongly contracted by the power of the will, while the blood is flowing out of an orifice made in one of its veins; that the force of the contraction at firſt accelerates the motion of the blood through the orifice, but ſoon retards and ſtops it, if the muſcles*

muſcles be kept in that contracted ſtate for any time.

Theſe changes made in the motion of the blood by the contraction of the muſcles evidently follow from the ſwelling of their membranes; for when the membranes of the muſcles ſwell by the vibrations of the *Æther*, they compreſs the blood-veſſels, and empty them. While the blood-veſſels are emptying, the motion of the blood through them is accelerated; but it is ſoon retarded and ſtopped, if the ſwelling of the membranes continues; for ſo long as the ſwelling continues, it will keep the veſſels cloſed, and hinder them from admitting any new blood into them. When the membranes contract, and the compreſſion of the veſſels ceaſes, the blood flows faſter into the empty veſſels than it did before, when the veſſels were full. Theſe are the changes made in the blood-veſſels and motion of the blood by the ſwelling and contracting of the membranes of the muſcles.

Hence we ſee how the motion of the blood is increaſed by the motion of the muſcles,

muscles, and why it is most increased in the muscles which are most used. The heart and other muscles increase or decrease in magnitude in proportion to the quantity of their action; and the magnitude of the system of blood-vessels, and the quantity of blood proportionable thereto, increase or decrease in proportion to the quantity of action of the heart and muscles. Hence labouring men, and men who use much exercise, have larger hearts, larger muscles, larger blood-vessels, and more blood than men who are indolent and inactive.

3. *By observing the pulse of several men after taking a vomit, it has been found, that so soon as a man begins to grow sick, his pulse becomes low, quick and irregular, and in the action of vomiting is often so low as not to be felt; that in the intervals between the vomits the pulse is still low and quick, but not near so low and quick as in the action of vomiting; and that after the whole operation is over, the pulse rises gradually, and in the space of half an hour or*

an

an hour, becomes fuller than it was before the vomit was taken.

Hence we ſee the effects of vomits on the motion of the blood; they leſſen that motion during the whole time of their operation, and almoſt quite ſtop it during the action of vomiting, by the ſtrong contraction they give to the muſcular ſyſtem; and after the operation is all over, they increaſe the motion of the blood, and make it greater than it was before.

And from theſe effects we diſcover the great uſefulneſs of vomits in ſtopping Hæmorrhages from ſmall veſſels, and in the cure of diſorders ariſing from a general want of motion in the blood, or from an irregularity and diſproportion in the motion of the blood and other fluids, in different parts of the body.

When I come to give an account of the virtues and operations of *Vomits*, I ſhall by a variety of CASES, ſhew their great uſefulneſs in the cure of diſeaſes.

To have muſcular motion performed with eaſe and vigour, the membranes muſt

not

not abound with fat or ferous moifture, which weaken the vibrating motion of the *Æther*, as we may gather from the following obfervations. Sounds caufed by a vibrating motion in the Air are weaker in a moift atmofphere than in a dry one; the founds of mufical cat-gut-ftrings caufed by the vibrating motion of the ftrings, become flatter and weaker by wetting the ftrings with water; and the electrical virtue of bodies, caufed by the vibrating motion of the *Æther*, is greatly weakened, if not entirely deftroyed, by water and watery moifture.

That accurate Anatomift and judicious obferver of the properties of mufcular motion, Mr. *Winflow*, faw clearly that none of the accounts he had met with could explain the properties of this motion; but on the contrary, that the Phænomena, when attentively confidered, deftroyed them all, not any one of them being an adequate, and confequently the true caufe of this motion. The *Æther* is both an adequate, and true caufe: It alone is fufficient, and does not admit of the affiftance of any animal

fluid

fluid for caufing this motion. Its vibrations on account of its great fubtilty, and the poroufnefs and uniformity of the nerves, may be propagated through them, without fuppofing the nerves to be pipes defigned for the conveyance of a fluid (called *animal fpirits)* fecerned by thefe pipes from the blood in the brain. The greater denfity of the *Æther* on the outfides of the nerves than within their pores, will hinder it from flying off, and thereby contribute and become neceffary to a regular propagation of its vibrations. Not even the beft microfcopes have ever been able to difcover the nerves to be pipes, as they muft be to convey a fluid fecerned from the blood to the mufcles. Therefore the fuppofition of *animal fpirits*, or any animal fluid having any fhare in caufing mufcular motion is an erroneous hypothefis, and ought to be rejected, as likewife ought all explanations of difeafes, built on that hypothefis.

A TABLE *of* SPECIFICK GRAVITIES, *by* *Sir* Isaac Newton.

Fine gold - - - - - -	19.640	Calculus humanus - -	1.700
Standard-gold - - - -	17.888	Oil of vitriol - - - -	1.700
Quick-silver - - - - -	14.000	Oil of tartar - - - - -	1.550
Lead - - - - - - - - -	11.325	Bezoar - - - - - - -	1.500
Fine silver - - - - - -	11.091	Honey - - - - - - -	1.450
Standard-silver - - - -	10.535	Gum arabic - - - - -	1.375
Bismuth - - - - - - -	9.700	Spirit of nitre - - - -	1.315
Copper - - - - - - -	9.000	Aqua fortis - - - - -	1.300
Cast brass - - - - - -	8.000	Pitch - - - - - - - - -	1.150
Steel the same piece } soft - - - -	7.738	Spirit of salt - - - - -	1.130
Steel the same piece } hard - - -	7.704	Spirit of urine - - - -	1.120
Steel the same piece } spring temper	7.809	Human blood - - - -	1.040
Iron - - - - - - - - - -	7.645	Amber - - - - - - - -	1.040
Tin - - - - - - - - - -	7.320	Serum of human blood	1.030
Glass of antimony - -	5.280	Milk - - - - - - - - -	1.030
A pseudo topaz - - -	4.270	Urine - - - - - - - - -	1.030
A diamond - - - - -	3.400	Dry box-wood - - - -	1.030
Clear cristal glass - -	3.150	Sea-water - - - - - -	1.030
Island cristal - - - - -	2.720	Common-water - - -	1.000
Fine marble - - - - -	2.700	Camphire - - - - - -	0.996
Rock cristal - - - - -	2.650	Bees-wax - - - - - -	0.955
Common green glass -	2.620	Linseed-oil - - - - - -	0.932
Stone of a mean gravity	2.500	Dry oak - - - - - - -	0.925
Sal gemmæ - - - - -	2.143	Oil olive - - - - - - -	0.913
Brick - - - - - - - - -	2.000	Spirit of turpentine - -	0.874
Nitre - - - - - - - - -	1.900	Rectified spirit of wine	0.866
Alabaster - - - - - - -	1.875	Dry ash - - - - - - - -	0.800
Dry ivory - - - - - -	1.825	Dry maple - - - - - -	0.755
Brimstone - - - - - -	1.800	Dry elm - - - - - - - -	0.600
Dantzick vitriol - - -	1.715	Dry fir - - - - - - - - -	0.550
Alum - - - - - - - - -	1.714	Cork - - - - - - - - - -	0.240
Borax - - - - - - - - -	1.714	Air - - - - - - - - - - -	0.001¼

Dr.

Dr. *Martine*, in the *Medical Eſſays*, mentions an experiment of the accurate Mr. *Boyle*'s, who diſtilled 10 ounces 73 grains, or 4873 grains, of human blood, at a ſlow fire; and, on conſidering the particulars of the proceſs, ſays, the blood conſiſting of 4873 grains being 1000, a Chymiſt would reckon its elements to be in the following proportions.

	Grains.	Grains.	Sp. grav.
Water -	4068	835	10000
Oil - -	333	68	9130
Salt - -	190	39	13000
Earth -	236	48	20000

Oil is ſpecifically lighter than water, and therefore it may be near the truth to ſuppoſe the ſpecifick gravity of the oily part of the blood to be 9130, the ſpecifick gravity of water being 10000. The ſalt of the blood is generally reckoned to be a kind of *Sal-armoniac*, whoſe ſpecifick gravity is about 13000. And Air, ariſing from denſe earthy ſubſtances by heat and fermentation, may be conſider-

ed as earth, and be added to it, and the ſum paſs under the name of Earth in the two columns. The grains of earth and Air in the firſt column contained in 4873 grains of blood were 65 and 171, and their ſum 236; and the grains of earth and air contained in 1000 grains of the ſame blood were 13 and 35, and their ſum 48 in the ſecond column. The ſpecifick gravity of earth may perhaps be about 20000, that is, twice as great as the ſpecifick gravity of water.

If the quantities of ſalt and earth in the ſecond column be added together, the ſum will be 17, and the ſpecifick gravity of the mixture will be 16111 by this *(g)* theorem $\frac{\overline{W+w}\times ab}{Wb+wa}$, in which W and w denote the weights of the ſalt and earth, and a and b their ſpecifick gravities, which are 13000 and 20000 in the Table; I ſay, the ſpecifick gravity of the mixture will be 16111, on ſuppoſition that the two ingredients take up as much ſpace in the mixture,

(g) Arithmetica univerſalis Newtoni, prob. 10. p. 89.

mixture, as they did before mixing. And if 87 the ſum of the ſalt and earth in this mixture, whoſe ſpecifick gravity is a = 16111, be conſidered as a new W; and 68 the quantity of oil, whoſe ſpecifick gravity is b = 9130, be added to the ſum of the ſalt and earth, we ſhall have a new mixture compoſed of the ſalt, earth and oil, whoſe quantity is 155, and whoſe ſpecifick gravity is 12064. And if we conſider 12064 as a new a, and 155 the ſum of the ſalt, earth and oil in the laſt mixture as a new W, and add 83·5 the quantity of water in 1000 grains of this blood, we ſhall have a new mixture compoſed of ſalt, earth, oil and water, whoſe ſpecifick gravity is 10274.

Now if a drachm of the mixture compoſed of ſalt, earth and oil, whoſe ſpecifick gravity is 12064, be mixed with 95 drachms of water, whoſe ſpecifick gravity is 10000, the ſpecifick gravity of this mixture will be 10018 by the theorem, in caſe there be no loſs of magnitude by mixing. If two drachms of the

the ſame mixture, compoſed of ſalt, earth and oil, be mixed with 94 drachms of water, the ſpecifick gravity of this mixture will be 10036. And if 22 drachms of the ſame mixture be mixed with 74 drachms of water, the ſpecifick gravity of this mixture will be 10408, which is nearly the ſame with the ſpecifick gravity of the blood in the foregoing Table, and the ſpecifick gravity of the *ſerum* correſponding with this blood is nearly the ſame with the ſpecifick gravity of the *ſerum* of the blood in the Table. The differences of the ſpecifick gravities of the blood and *ſerum* in the Table, from the ſpecifick gravity of water, are 400 and 300, which are as 1 and 0.75. And therefore, if the differences of the ſpecifick gravities of the blood, from the ſpecifick gravity of water, be each of them multiplied by 0.75, the reſpective products will be the differences of the ſpecifick gravity of the correſponding *ſerum*, from the ſpecifick gravity of water. Thus I have formed the following Table, by which it appears,

pears, that from the ſpecifick gravity of the *ſerum*, (which may be known by a good hydroſtatical ballance) we may in ſome meaſure judge how the blood of that *ſerum* is loaded with contents. For inſtance, if the ſpecifick gravity of the *ſerum* be 10305, the ſpecifick gravity of the blood of that *ſerum* will be 10408; and a troy pound of that blood will contain 22 drachms of a mixture of ſalt, earth and oil, and 74 drachms of water. If the ſpecifick gravity of the *ſerum* be 10408, the ſpecifick gravity of the blood belonging to that *ſerum* will be 10545, and a troy pound of that blood will contain 29 drachms of ſalt, earth and oil, and 67 drachms of water: This was nearly the ſpecifick gravity of the *ſerum* of the blood in the mortal inflammatory fever, deſcribed by *Tabor*. I have examined the *ſerum* of the blood of many perſons under inflammatory fevers in this kingdom, but never found its ſpecifick gravity ſo great as in this fever in *England*. It ſeldom riſes here to above 10369; which perhaps may be owing to the Air being moiſter here than in *England*.

Number

Number of drachms in a troy pound.	Specifick gravity of the *serum.*	Specifick gravity of the blood.
1	10013	10018
2	10027	10036
3	10041	10055
4	10052	10072
5	10067	10090
6	10081	10108
7	10094	10126
8	10108	10144
9	10122	10163
10	10136	10181
11	10150	10200
12	10163	10218
13	10178	10237
14	10192	10256
15	10205	10274
16	10220	10294
17	10234	10312
18	10248	10331
19	10262	10350
20	10277	10369
21	10292	10389
22	10305	10408
23	10320	10427
24	10335	10447
25	10349	10466
27	10364	10486
26	10379	10505
29	10394	10525
28	10408	10545
30	10424	10565
31	10438	10585
32	10454	10605

The blood both in health and diſeaſes may differ in the natures and proportions of its component parts, in bodies of different ages and ſexes, in different ſeaſons of the year, and different climates; and it were to be wiſhed, that this was known by accurate experiments, like that which was made by Mr. *Boyle*, and deſcribed by Dr. G. *Martine*. Till this is done, it may be of ſome uſe to know in general, that a yellow and high-coloured *ſerum* denotes the blood to abound with bile, and be hot; and a heavy *ſerum* ſhews it to abound with the heavier contents of ſalt and earth. Spirit of wine is ſpecifically lighter and more acrid than oil, which ſhews that oil is rarefied and rendered acrid by heat and fermentation. So that by knowing the degree of external heat of the body, which may be had by a good thermometer, we may in ſome degree judge of the nature and texture of the blood.

I ſhall now give Sir *Iſaac Newton*'s Paper, *De natura acidorum*, publiſhed in the ſecond volume of *Harris's Lexicon.*

Acidorum particulæ ſunt aqueis craſſiores, & propterea minus volatiles, at terreſtribus multo ſubtiliores, & propterea multo minus fixæ. Vi magnâ attractivâ pollent, & in hac vi conſiſtit earum activitas, quâ & corpora diſſolvunt, & organa ſenſuum agitant & pungunt. Mediæ ſunt naturæ inter aquam & corpora, & utraque attrahunt. Per vim ſuam attractivam congregantur circum particulas corporum, ſeu lapideas ſeu metallicas, iiſque undique adhærent arctiſſimè, ut ab iiſdem deinceps per diſtillationem vel ſublimationem vix poſſint ſeparari; attractæ vero & undique congregatæ, elevant, disjungunt & diſcutiunt particulas corporum ab invicem, id eſt, corpora diſſolvunt; & per vim attractionis, quâ ruunt in particulas, commovent fluidum & ſic calorem excitant, particulaſque nonnullas adeo diſcutiunt ut in Aerem convertant & ſic bullas generant. Et hæc eſt ratio diſſolutionis & fermentationis; acidum verò attrahendo aquam æquè ac terram efficit, ut particulæ diſſolutæ prompte miſceantur cum aquâ eique innatent ad modum ſalium. Et quemadmodum globus

terræ

terræ per vim gravitatis attrahendo aquam fortiùs quam corpora leviora, efficit ut leviora aſcendant in aquâ, & fugiant de terrâ. Sic particulæ ſalium attrahendo aquam fugant ſe mutuo, & ab invicem quam maximè recedendo, per aquam totam expanduntur.

Particulæ ſalis alkali ex terreis & acidis ſimilitèr unitis conſtant; ſed hæ acidæ vi maximâ attractivâ pollent, ut per ignem non ſeparentur à ſale; utque metalla diſſoluta præcipitant, attrahendo ab ipſis particulas acidas quibus diſſolvebantur.

Si particulæ acidæ in minori proportione cum terreſtribus jungantur, hæ tam arcte retinentur à terreſtribus, ut ab iis ſupprimi ac occultari videantur. Neque enim ſenſum jam pungunt, neque attrahunt aquam, ſed corpora dulcia & quæ cum aquâ ægre miſcentur, hoc eſt *pinguia*, componunt; ut fit in mercurio dulci, ſulphure communi Luna *Cornea*, & cupro quod mercurius ſublimatus corroſit. Ab acidi vero ſic ſuppreſſi vi attractivâ, fit, ut pinguia corporibus prope univerſis adhæreant & flammam facilè concipiant, ſi modo acidum calefac-

tum inveniat alia corpora in fumo accenſorum quæ fortius attrahat quam propria. Sed & acidum in ſulphureis ſuppreſſum, fortius attrahendo particulas aliorum corporum (ſcilicet terreas) quam proprias, fermentationem lentam & naturalem ciet & fovet uſque ad putrefactionem compoſiti.

Quæ putrefactio ſita eſt in eo quod acidæ fermentationem diu foventes, tandem in interſtitia minima, & *primæ compoſitionis* partes interjacentia ſeſe inſinuant, intiméque iis partibus unitæ mixtionem novam efficiunt non amovendam nec cum priore commutandam.

Cogitationes variæ ejuſdem.

Flamma eſt fumus candens; differtque à fumo, ut ferrum rubens ab ignito ſed non rubente.

Calor eſt agitatio partium quaque verſum.

Nihil eſt abſolutè quieſcens ſecundum partes ſuas, & ideo frigidum, præter atomos, vacui ſcilicet expertes.

Terra

Terra augetur, aquâ in eam converſâ: & omnia in aquam [vi ignis] reduci poſſunt.

Nitrum abit diſtillatione magnam partem in ſpiritum acidum, relictâ terrâ, quia acidum nitri attrahit phlegma; & idcirco ſimul aſcendunt conſtituuntque ſpiritum: at nitrum carbone accenſum magnam partem abit in ſal tartari, quia ignis eo modo applicatus partes acidi & terræ in ſeſe impingit fortiuſque unit.

Spiritus ardentes ſunt olea cum phlegmate per fermentationem unita.

Tinctura cochinellæ cum ſpiritu vini facta in aquæ magnam molem immiſſa, parva licet doſi, totam aquam inficit: ſcilicet, quia particulæ cochinellæ magis attrahuntur ab aquâ quam à ſe mutuo.

Aqua non habet magnam vim diſſolvendi quia pauco acido gaudet. Acidum enim dicimus quod multum attrahit & attrahitur, videmus nempe ea quæ in aquâ ſolvuntur lente & ſine efferveſcentiâ ſolvi, at ubi eſt attractio fortis & particulæ menſtrui undique attrahuntur à particulâ metalli, vel potius particula metalli undique attrahitur

hitur à particulis menſtrui, hæ illam abripiunt & circumſiſtunt, hoc eſt metallum corrodunt: hæ eædem particulæ ſenſorio applicatæ ejus partes eodem modo divellunt doloremque inferunt; à quo acidæ appellantur, relictâ ſcilicet terrâ ſubtili cui adhærebant ob majorem attractionem ad liquidum linguæ, *&c.*

In omni ſolutione per menſtruum, particulæ ſolvendæ magis attrahuntur a partibus menſtrui quam à ſe mutuo.

In omni fermentatione eſt acidum ſuppreſſum quod coagulat præcipitando.

Oleum cum nimis magnâ mole phlegmatis intime mixtum, fit ſalinum quiddam & ſic acetum conſtituit, hic etiam tartari ſeu terræ admiſtæ habenda eſt ratio.

Mercurius attrahitur, id eſt, corroditur ab acidis; & ſicut pondere obſtructiones tollit, ita vi attractrice acida infringit.

Mercurius eſt volatilis & facile elevatur calore, quia ejus particulæ *ultimæ compoſitionis* ſunt parvæ & facile ſeparantur ſeparatæque ſeſe fugant; ut in particulis vaporis, fluidorumque rarefractorum.

Aqua comprimi non poteſt quia ejus particulæ jamjam ſe tangunt. Et ſi ſe tangerent particulæ Aeris (nam Aer comprimi poteſt, quia ipſius particulæ nondum ſe tangunt) Aer evaderet in marmor. Seq. ex prop. 23. lib. 2. Princ. Philoſoph.

Aurum particulas habet ſe mutuo trahentes; minimarum ſummæ vocentur *primæ compoſitionis*, harum ſummarum ſummæ *ſecundæ compoſitionis*, &c.

Poteſt mercurius, poteſt aqua regia, poros pervadere, qui particulas *ultimæ compoſitionis* interjacent at non alios.

Si poſſet menſtruum alios illos pervadere, vel ſi aura partes *primæ* & *ſecundæ compoſitionis* poſſent ſeparari, fieret aurum, vel fluidum, vel ſaltem magis malleabile. Si aurum fermenteſcere poſſet, in aliud quodvis corpus poſſet transformari.

Viſciditas eſt, vel ſolum defectus fluiditatis quæ ſita eſt in partium parvitate & ſeparabilitate (intellige partes ultimæ compoſitionis), vel defectus lubricitatis ſeu lævioris partes unius ſupra alias labi impediens. Hujus viſciditatis acidum ſæpe cauſa eſt; ſæpe ſpiritus alius lubricus terræ junctus,

ut oleum terebinthinæ capiti ſuo mortuo redditum fit tenax.

Ratio cur charta oleo inuncta tranſitum oleo, non aquæ, concedat, eſt quia aqua oleo non miſcetur, ſed fugatur ab eo.

Cum acidæ partes, minores ſcilicet, aliquid diſſolvunt, id faciunt, quia partem rei ſolvendæ includunt undique, utpote majorem quâlibet acidi partium.

Sir *Iſaac Newton* computed the refractive forces of tranſparent bodies from the ſines of incidence and refraction of yellow light, and then compared thoſe forces with the denſities of the ſame bodies, and found the forces to be very nearly proportional to the denſities of the bodies, excepting that unctuous and ſulphureous bodies refract more than others of the ſame denſity. His Table in page 247 of the *Opticks* contains the proportions of the ſines, the refractive forces, the denſities, and the refractive forces in proportion to the denſities. And I have contracted his Table into the following one, by omitting the proportions of the ſines, and taking means of the

the terreſtrial, ſtony, alcalizate concretes, of the ſalts, and of the fat, ſulphureous unctuous bodies in his Table, and placing theſe means under the names of earthy bodies, ſalts, oils, and unctuous bodies in this Table.

The refractive bodies.	The refractive power $= R$	The denſity. $= \Delta$	The refractive power in reſpect of the denſity. $= \frac{R}{\Delta}$
Air - - - - - - - - - - - - -	0.000625	0.0012	5208
Earthy bodies - - - - - -	1.68425	3.292	5116
Salts - - - - - - - - - - - -	1.26156	1.8372	6866
Oil of vitriol - - - - - - -	1.041	1.7	6124
Rain water - - - - - - - -	0.7845	1.	7845
Gum arabick - - - - - - -	1.179	1.375	8574
Spirit of wine well rectified	0.8765	0.866	10121
Oils and unctuous bodies - -	1.2357	0.951	12993
A diamond - - - - - - - -	4.949	3.4	14556

" The refraction of the Air in this Table is determined by that of the atmoſphere obſerved by aſtronomers. For if *Light* paſs through many refracting ſubſtances or mediums gradually denſer

 " and

" and denſer, and terminated with paral-
" lel ſurfaces, the ſum of all the refrac-
" tions will be equal to the ſingle refrac-
" tion which it would have ſuffered in
" paſſing immediately out of the firſt me-
" dium into the laſt. And this holds true,
" though the number of the refracting
" ſubſtances be increaſed to infinity, and
" the diſtances from one another as much
" decreaſed, ſo that the *Light* may be re-
" fracted in every point of its paſſage,
" and by continual refractions bent into
" a curve line. And therefore the whole
" refraction of *Light* in paſſing through
" the atmoſphere from the higheſt and ra-
" reſt part thereof down to the loweſt and
" denſeſt part, muſt be equal to the re-
" fraction which it would ſuffer in paſ-
" ſing at like obliquity out of a vacuum
" immediately into Air of equal denſity
" with that in the loweſt part of the at-
" moſphere.

" Now although a pſeudo-topaz, a ſe-
" lenitis, rock cryſtal, iſland cryſtal, vul-
" gar glaſs, (that is, ſand melted toge-
" ther) and glaſs of antimony, which are
" terreſtrial,

" terreſtrial, ſtony, alcalizate concretes,
" and Air which probably ariſes from
" ſuch ſubſtances by fermentation, be
" ſubſtances very differing from one ano-
" ther in denſity, yet by this Table, they
" have their refractive powers almoſt
" in the ſame proportion to one another
" as their denſities are, excepting that
" the refraction of that ſtrange ſubſtance
" iſland cryſtal is a little bigger than the
" reſt. And particularly Air, which is
" 3500 times rarer than the pſeudo-to-
" paz, and 4400 times rarer than glaſs of
" antimony, and 2000 times rarer than
" the ſelenitis, glaſs vulgar, or cryſtal of
" the rock, has notwithſtanding its rarity
" the ſame refractive power in reſpect of
" its denſity which thoſe very denſe ſub-
" ſtances have in reſpect of theirs, ex-
" cepting ſo far as thoſe differ from one
" another.

" Again, camphire, oil olive, linſeed oil,
" ſpirit of turpentine and ambar, which
" are fat ſulphureous unctuous bodies, and
" a diamond, which probably is an unc-
" tuous ſubſtance coagulated, have their

" refractive powers in proportion to one
" another as their densities without any
" considerable variation. But the refrac-
" tive powers of these unctuous substan-
" ces are two or three times greater in
" respect of their densities, than the re-
" fractive powers of the former substan-
" ces in respect of theirs.

" Water has a refractive power in a
" middle degree between those two sorts
" of substances, and probably is of a mid-
" dle nature. For out of it grow all ve-
" getable and animal substances, which
" consist as well of sulphureous fat and
" inflamable parts, as of earthy lean and
" alcalizate ones.

" Salts and vitriols have refractive pow-
" ers in a middle degree between those of
" earthy substances and water, and accor-
" ingly are composed of those two sorts of
" substances. For by distillation and rec-
" tification of their spirits a great part of
" them goes into water, and a great part
" remains behind in the form of a dry
" fixed earth capable of vitrification.

" Spirit

" Spirit of wine has a refractive power
" in a middle degree between those of
" water and oily substances and accord-
" ingly seems to be composed of both, u-
" nited by fermentation; the water, by
" means of some saline spirits with which
" 'tis impregnated, dissolving the oil, and
" volatilizing it by the action. For spi-
" rit of wine is inflamable by means of its
" oily parts, and being distilled often from
" salt of tartar, grows by every distillati-
" on more and more aqueous and phleg-
" matick. And Chymists observe, that
" vegetables (as lavender, rue, marjoram,
" *&c.)* distilled *per se*, before fermenta-
" tion yield oils without any burning spi-
" rits, but after fermentation yield ardent
" spirits without oils: which shews, that
" their oil is by fermentation converted
" into spirit. They find also, that if oils
" be poured in small quantity upon fer-
" mentating vegetables, they distil over af-
" ter fermentation, in the form of spirits.

" So then by the foregoing Table, all
" bodies seem to have their refractive
" powers proportional to their densities, (or

" very

"very nearly;) excepting so far as they "partake more or less of sulphureous oi- "ly particles, and thereby have their re- "fractive power made greater or less. "Whence it seems rational to attribute "the refractive power of all bodies chief- "ly, if not wholly, to the sulphureous "parts with which they abound. For its "probable that all bodies abound more or "less with sulphurs. And as *Light* con- "gregated by a burning-glass, acts most "upon sulphureous bodies, to turn them "into fire and flame; so, since all action "is mutual, sulphurs ought to act most "upon *Light*. For that the action be- "tween *Light* and bodies is mutual, may "appear from this Consideration; That "the densest bodies which refract and re- "flect *Light* most strongly grow hottest "in the Summer sun, by the action of "the refracted or reflected *Light*."

Common salt taken with the food is first changed in the body into a kind of sal-armoniac, which is more volatile, and specifically lighter than common salt. It is more volatile than common salt, from its

"particles

particles being ſmaller than the particles of common ſalt, and it is ſpecifically lighter than common ſalt, from the expanſive force of the *Æther* in the blood being greater as the natural heat of the blood is greater than the meridian heat of the Air in Summer. How the particles of ſal-armoniac come to be ſmaller than the particles of common ſalt, may be underſtood from Sir *Iſaac Newton*'s account of the compoſition of the particles of ſalt deduced from experiments. The experiments from which he deduced the compoſition of particles of ſalt, are theſe.

" When mercury ſublimate is reſubli-
" med with freſh mercury, and becomes
" *mercurius dulcis*, which is a white taſte-
" leſs earth, ſcarce diſſolvable in water,
" and *mercurius dulcis* reſublimed with
" ſpirit of ſalt returns into mercury ſubli-
" mate; and when metals corroded with
" a little acid turn into ruſt, which is an
" earth taſteleſs and indiſſolvable in wa-
" ter, and this earth imbibed with more a-
" cid becomes a metallick ſalt; and when
" ſome ſtones, as ſpar of lead, diſſolved
" in

" in proper *menſtruums*, become ſalts; do
" not theſe things ſhew, that ſalts are dry
" earth and watry acid united by attrac-
" tion, and that the earth will not become
" a ſalt without ſo much acid as makes it
" diſſolvable in water? Do not the ſharp
" and pungent taſtes of acids ariſe from
" the ſtrong attraction whereby the acid
" particles ruſh upon and agitate the par-
" ticles of the tongue? And when metals
" are diſſolved in acid *menſtruums*, and
" the acids in conjunction with the metal
" act after a different manner, ſo that the
" compound has a different taſte much
" milder than before, and ſometimes a
" ſweet one; is it not becauſe the acids
" adhere to the metallick particles, and
" thereby loſe much of their activity?
" And if the acid be in too ſmall a pro-
" portion to make the compound diſſolv-
" able in water, will it not by adhering
" ſtrongly to the metal become unactive
" and loſe its taſte, and the compound be
" a taſteleſs earth? for ſuch things as are
" not diſſolvable by the moiſture of the
" tongue, act not upon the taſte.

" As

"As gravity makes the fea flow round "the denfer and weightier parts of the "globe of the earth, fo the attraction may "make the watry acid flow round the "denfer and compacter particles of earth "for compofing the particles of falt. For "otherwife the acid would not do the "office of a medium between the earth "and common water, for making falts "diffolvable in the water; nor would falt "of tartar readily draw off the acid from "diffolved metals, nor metals the acid "from mercury. Now as in the great "globe of the earth and fea, the denfeft "bodies by their gravity fink down in wa-"ter, and always endeavour to go to-"wards the center of the globe; fo in "particles of falt, the denfeft matter may "always endeavour to approach the cen-"ter of the particle: fo that a particle of "falt may be compared to a chaos; being "denfe, hard, dry, and earthy in the cen-"ter; and rare, foft, moift, and watry in "the circumference. And hence it feems "to be that falts are of a lafting nature, "being fcarce deftroyed, unlefs by draw-

" ing away their watry parts by violence, " or by letting them ſoak into the pores " of the central earth by a gentle heat in " putrefaction, until the earth be diſſolv- " ed by the water, and ſeparated into " ſmaller particles, which by reaſon of " their ſmallneſs make the rotten com- " pound appear of a black colour. Hence " alſo it may be that the parts of animals " and vegetables preſerve their ſeveral " forms, and aſſimilate their nouriſhment; " the ſoft and moiſt nouriſhment eaſily " changing its texture by a gentle heat and " motion, till it becomes like the denſe, " hard, dry, and durable earth in the cen- " ter of each particle. But when the nou- " riſhment grows unfit to be aſſimilated, " or the central earth grows too feeble to " aſſimilate it, the motion ends in confu- " ſion, putrefaction and death.

" If a very ſmall quantity of any ſalt " or vitriol be diſſolved in a great quan- " tity of water, the particles of the ſalt " or vitriol will not ſink to the bottom, " though they be heavier in ſpecie than " the water, but will evenly diffuſe them-

" ſelves

" ſelves into all the water, ſo as to make
" it as ſaline at the top as at the bottom.
" And does not this imply that the parts
" of the ſalt or vitriol recede from one a-
" nother, and endeavour to expand them-
" ſelves, and get as far aſunder as the
" quantity of water in which they float,
" will allow? And does not this endea-
" vour imply that they have a repulſive
" force by which they fly from one ano-
" ther, or at leaſt, that they attract the
" water more ſtrongly than they do one
" another? For as all things aſcend in wa-
" ter which are leſs attracted than water,
" by the gravitating power of the earth;
" ſo all the particles of ſalt which float in
" water, and are leſs attracted than wa-
" ter by any one particle of ſalt, muſt re-
" cede from that particle, and give way to
" the more attracted water.

" When any ſaline liquor is evaporated
" to a cuticle and let cool, the ſalt con-
" cretes in regular figures; which argues,
" that the particles of the ſalt before they
" concreted, floated in the liquor at equal
" diſtances in rank and file, and by con-

" ſequence that they acted upon one ano-
" ther by ſome power which at equal di-
" ſtances is equal, at unequal diſtances un-
" equal. For by ſuch a power they will
" range themſelves uniformly, and with-
" out it they will float irregularly, and
" come together as irregularly. And ſince
" the particles of iſland cryſtal act all the
" ſame way upon the Rays of *Light* for
" cauſing the unuſual refraction, may it
" not be ſuppoſed that in the formation of
" this cryſtal, the particles not only rang-
" ed themſelves in rank and file for con-
" creting in regular figures, but alſo by
" ſome kind of polar virtue turned their
" homogeneal ſides the ſame way?"

From this account of the compoſition of particles of ſalt, we may eaſily conceive how an increaſed heat by increaſing the vibrating motion and expanſive force of the *Æther*, may throw off ſome part of the ſuperficial acid, whoſe particles being of a watry nature cohere much leſs ſtrongly than the particles of the central earth; and ſo by leſſening the magnitudes of the particles may render them more volatile.

And

And a greater degree of heat in the blood, ſuch as is that of an ardent fever, may ſtill render the ſalts of the blood more volatile by throwing off more of their ſuperficial acid. Another way of drawing off the ſuperficial acid from particles of ſalt, is when it is more ſtrongly attracted by other bodies, than by its own central earth; for in this caſe, it will be drawn from its own earth, and united with thoſe bodies. Salt of tartar deſtroys metallick ſalts, by forcibly drawing away their ſuperficial acid from the central metallick earth, which earth, when deprived of its acid, becomes inactive, and entirely loſes the nature of ſalt.

The way in which ſalts are deſtroyed, by drawing away the watry acid by violence, may be underſtood by the following obſervations.

" A ſolution of ſilver in *aqua fortis*
" poured upon copper, diſſolves the cop-
" per and lets go the ſilver; a ſolution of
" copper poured upon iron, diſſolves the
" iron and lets go the copper; a ſolution
" of iron poured upon *lapis calaminaris*
" or

" or zink, diſſolves the *lapis calaminaris* " or zink and lets go the iron; a ſolution " of zink poured upon chalk, crabs eyes " or oyſter-ſhells diſſolves the chalk, " crabs-eyes or oyſter-ſhells and' lets go " the zink; a ſolution of chalk, crabs- " eyes or oyſter-ſhells mixed with ſpirit " of ſal-armoniac, unites with the ſpirit " and lets go the chalk, crabs-eyes or oy- " ſter-ſhells; and this mixture poured up- " on ſalt of tartar *per deliquium*, diſſolves " the ſalt and lets go the volatile ſpirits. " Hence the acid particles of *aqua fortis* " are attracted more ſtrongly by copper " than by ſilver, and more ſtrongly by " iron than by copper, and more ſtrong- " ly by *lapis calaminaris* or zink than by " iron, and more ſtrongly by chalk, crabs- " eyes or oyſter-ſhells than by zink, and " more ſtrongly by ſpirit of ſal-armoniac " than by chalk, crabs-eyes or oyſter- " ſhells, and more ſtrongly by ſalt of tar- " tar *per deliquium* than by ſpirit of ſal- " armoniac."

From

From the experiments of *Langriſh*, I drew this Table, in which the column $\frac{R}{S}$

	$\frac{R}{S}$	T	$\frac{R}{ST}$
Health - - -	10000	10000	10000
Continued fever	28198	25799	10929
Quotidian fever	22916	20505	11127
Tertian fever -	22136	18591	11906
Quartan - - -	17533	14471	12113

exhibits the proportion of the red part of the blood, to the *ſerum* ſeparated from it in 24 hours in health, in a continual, quotidian, tertian and quartan fever. $\frac{R}{S}$ was the mean of 16 experiments in the continual fever, of 12 in the quotidian and tertian, and of 10 in the quartan. The column T exhibits the mean tenacity, or mean degree of coheſion of the *craſſamentum* or red part of the blood, meaſured by a weight juſt ſufficient to ſeparate its parts. And the laſt

laſt column $\frac{R}{ST}$, exhibits the proportions of the numbers in the column $\frac{R}{S}$ to the corresponding numbers in the column T.

Hence it appears, that the proportion of the *craſſamentum* to the *ſerum* and the tenacity of the blood, that is $\frac{R}{S}$ and T, are both of them greater in all kinds of fevers than in health; that they are greater in continual fevers than in quotidians, in quotidians than in tertians, and in tertians than in quartans; and that the *craſſamentum* to the *ſerum* with reſpect to the tenacity, that is $\frac{R}{ST}$, is pretty much the ſame in all kinds of fevers, only it is ſomething leſs in continual and quotidian fevers than in tertians and quartans. Hence it appears, that either $\frac{R}{S}$ or T may ſerve as a meaſure of the tenacity of the blood when cold. In fizy blood we may judge of its tenacity, as far as is neceſſary for uſe, by the thickneſs of its fizy coat and the reſiſtance it gives to the finger preſſing upon it at its entrance.

The

The coat is thicker and the refiftance greater in the fizy blood of old than in the fizy blood of young bodies, of men than of women, and of perfons of ftrong than of perfons of weak fibres.

As to any farther particulars relating to thefe experiments, I refer to his own Tables which feem to have been made with care. His Tables would have been fomething more perfect, if he had given us the fpecifick gravity of the *ferum*. That may in fome meafure be fupplied by the fpecifick gravities of the blood and *ferum* in the Table above.

When the blood by the antecedent caufes is rendered fo thick and tenacious, as not to be able to pafs through the fmalleft veffels, the body grows chill and cold, and is feized with a fhivering and fhaking, as bodies commonly are on their being fuddenly expofed to a cold fharp Air. During the continuance of thefe fymptoms, the pulfe is very low and quick, and if a vein be opened, the blood flows out flowly by drops, which fhews that the blood then is almoft in a ftate of ftagnation. The fhi-

vering, which is caufed by an alternate contraction and dilatation of the mufcles, by degrees gives motion to the tenacious and vifcid blood ftagnating in the capillary blood-veffels, and forming obftructions. That the motion of the mufcles increafes the motion of the blood, has been fhewn in the *Differtation on the Food and Difcharges of human Bodies*, and in the *Appendix to Sir* Ifaac Newton's *Account of the Æther*. And that an increafed motion of the blood can remove obftructions caufed by grumous blood ftagnating in the blood-veffels, appears evidently from microfcopical obfervations.

" *Lewenhoek*, who fpent much time in " obferving the motion of the blood with " glaffes in the tranfparent parts of ani- " mals, fometimes obferved the blood to " ftagnate in a veffel, as at R, (Fig. 1. " p. 104.) and could not obferve any fe- " parate parts in it, by reafon of its ap- " pearing of one uniform red colour. " This being fo, he obferved the blood " at every pulfation of the heart to be " propelled from N to P, and as often as

" it

" it was puſhed forward to come back
" again, ſo that it had a motion like that
" of a ſaw. By the force of this mo-
" tion the blood began to move from P
" to R, yet ſo as to be forced back again
" in like manner as in NP; and thus
" by degrees the obſtruction was remov-
" ed, and the motion reſtored. Before
" the motion was reſtored in the obſtruct-
" ed veſſel PR, he obſerved the branch
" MO to be a little diſtended, as indeed
" it ought to be from the nature of the
" blood's motion. For when one veſſel
" is obſtructed, the neighbouring bran-
" ches muſt be enlarged to receive the
" blood that paſſed through the veſſel PR
" before it was obſtructed. Hence he
" rightly concluded, that blood ſtagnating
" in the veſſels may be reſtored to its mo-
" tion by the repeated pulſations of the
" heart, and that the red globules coagu-
" lated may by the ſame force be freed
" from their coagulation, and made to aſ-
" ſume their former figure. Hence like-
" wiſe blood coagulated by a ſtroke or
" bruiſe, may in ſome days by the re-

 " peated

" peated pulſations of the heart, be diſ-
" ſolved again and reſtored to its mo-
" tion.

" In a ſmall artery as OM opening out
" of a larger, he has ſeen the blood not
" only to ſtop on a ſudden in its progreſs
" from M to O, but likewiſe to become
" retrogade, ſo as to be poured back into
" the artery LMN, which he imputed to
" ſome ſudden obſtruction in MO, or
" ſome of its branches, either from a co-
" agulation of the blood, or from the
" preſſure of a muſcle, or ſome external
" preſſure which he rather ſuſpected, be-
" cauſe after a very ſhort time, the motion
" was reſtored, and the blood again mo-
" ved through MO as faſt as it did be-
" fore.

" He has ſeen a groſs particle of blood
" protruded through an artery, which fil-
" led up its whole cavity, which particle
" after a little while ran back again, from
" its meeting, as he ſuſpected, with bran-
" ches too ſmall to admit it; and then it
" went forward again from a new pulſa-
" tion, and continued in this reciprocal
" motion.

" motion. He has likewiſe ſeen coagu-
" lated blood put again in motion by
" warmth, and he has obſerved its mo-
" tion towards the heart to be augmented
" on its coming into a larger part of a
" vein; for inſtance, he has ſeen it coa-
" gulated at D, (Fig. 2. p. 104.) and af-
" ter it has been protruded into DE a
" larger part of the vein, to have mov-
" ed on very quick. He has ſeen blood
" coagulated in a large branch, as above F
" and about B, agitated ſo long till it has
" been protruded into the larger ſpace
" BC, in which it then moved on very
" quick. After two days, he again ob-
" ſerved the motion of the blood in the
" ſame creature, which was a bat, and
" found the blood more coagulated in
" the ſame veſſels, and though the blood
" would then move to and fro upon the
" application of heat, yet heat would not
" then give it a progreſſive motion. Be-
" ſides he obſerved the coagulation had
" extended itſelf to other veſſels, and
" that it increaſed and extended ſtill far-
" ther in twenty-four hours more. Af-

“ ter that, for ſix days he obſerved no
“ change, though he kept the bat warm;
“ but from that time, he obſerved the
“ blood to become more and more coa-
“ gulated, and the animal to grow ſo
“ weak that it had not power to creep.

“ Any preſſure or hurt impedes the
“ circulation of the blood. He ſome-
“ times perceived the blood to be coagu-
“ lated in the ſmall veſſels, and yet to cir-
“ culate freely in veſſels which were lar-
“ ger. He ſays, if you carefully obſerve
“ eels, you may perceive them begin to
“ die from a retardation of the blood's
“ motion; which retardation increaſing,
“ at laſt you can ſcarcely perceive any
“ motion; and yet even then the motion
“ may be renewed for a few moments,
“ till at laſt it ceaſes entirely and they
“ die. The motion of the blood in fiſh,
“ begins to be retarded in leſs than a mi-
“ nute after they are taken out of the
“ water; and the ſame happens to birds
“ and beaſts in the air-pump, after the air
“ is drawn out.

" In obſerving a tadpole with great at-
" tention, he could not diſcover any mo-
" tion in the blood, which upon exami-
" nation he found was owing to the fore-
" part of its body being ſqueezed, and
" the heart of the little animal ſo op-
" preſſed by it that it could not per-
" form its office in keeping up the mo-
" tion of the blood. Under this oppreſ-
" ſion, the little creature made a ſtrong
" motion with its tail and body, beating
" about with its tail and bending and
" twiſting its body, till its heart got free
" from its oppreſſion and was reſtored
" to its motion. As the heart began to
" get rid of its oppreſſion, he obſerved
" the blood began to move with a ſmall
" motion, which motion was increaſed by
" degrees till it was quite reſtored to its
" natural ſtrength, only he judged the
" motion to be ſomething ſlower than it
" would have been if the animal had not
" been hurt."

Theſe obſervations ſhew, that obſtructions in the blood-veſſels, and of conſequence, in all the ſmaller veſſels of animal bodies,

bodies, which veſſels are continuations of the laſt branches of the blood-veſſels, are removed by heat, and by the motions of the blood and muſcles. Heat thins and rarefies tenacious and viſcid blood, as appears from the ſwelling of the blood-veſſels when a body is hot, and their contraction when a body is cold.

And heat likewiſe increaſes the motion of the blood, as appears from the fulneſs and quickneſs of the pulſe, when a body is heated by exerciſe or a fever. Muſcles, when they contract, compreſs the blood-veſſels lying within them, and by that compreſſion increaſe the motion of the blood, as has been ſhewn above; and of conſequence, much motion of the muſcles greatly contributes to remove obſtructions.

From the weight of the body being increaſed at the beginning of almoſt all fevers it appears, that the diſcharges muſt have been leſſened and have fallen ſhort of the food for ſome little time before, and that they muſt likewiſe have been more watry, may be gathered from the ſpecifick

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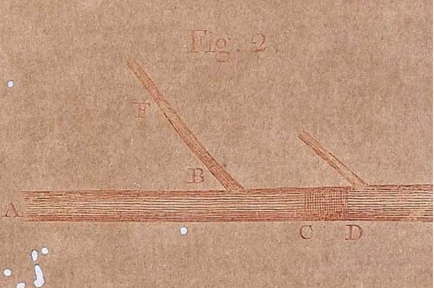
Fig. 1

Fig. 2



ſpecifick gravity, and colour of the urine, being both of them leſs after eating than before, and after a plentiful meal than after a ſpare one.

A quick increaſe of weight neceſſary to bring on a fever, is commonly greateſt in perſons of the ſtrongeſt fibres. Conſequently it is greater in men than in women, in old bodies than in young, and in Winter than in Summer. And what is true of the increaſe of weight, holds equally true of the tenacity of the blood, which is greater or leſs according to the ſtrength of the fibres. Hence we ſee the reaſon why fevers are more or leſs dangerous, in proportion to the ſtrength of the fibres; and conſequently, why they are more dangerous in men than in women, and in old bodies than in young bodies.

From what has been ſaid, it evidently appears that a præternatural heat in the blood, and an increaſe of the blood's motion, are the inſtruments uſed by nature in the cure of fevers. Nothing rarifies and attenuates viſcid blood ſo much as heat, and nothing gives motion to blood ſtag-

nating in the capillaries ſo effectually as an increaſed motion of the blood cauſed by an augmented motion of the heart and muſcles. Heat, by rarifying the oily parts of the blood leſſens its tenacity, or makes the blood more fluid; and by making the blood more fluid, and enlarging the capacities of the blood-veſſels, it leſſens the reſiſtance given to the forces of the heart and arteries, and to the contracting force of the muſcles; and by leſſening the reſiſtance given by the blood to theſe forces, it neceſſarily augments its motion. Heat rarifies and leſſens the tenacity of fluids. Oil, balſam, honey, a ſtrong ſolution of ſoap in water, and mucilages, which are tenacious liquids, are rarified and rendered more fluid by heat; and the crude oil of vegetable juices is rarified and turned into a very fluid ſpirit, by a gentle heat in fermentation.

There ſeems to be a great analogy between the fining of vegetable liquors by fermentation, and the fining of the blood of animals by a fever. Weak liquors are ſooner fined by fermentation than ſtrong liquors;

liquors; and the blood of children is fooner depurated by a fever than the blood of old bodies, from its being more watry, and abounding lefs with earthy faline and oily parts. The time required for depurating the blood by a fever will vary with the heat and tenacity of the blood. The time will be greater when the tenacity is greater, or the heat lefs; and the time will be lefs when the tenacity is lefs, or the heat greater. If T denote the tenacity, and H the heat of the blood in a fever, the time of the fever's continuance may be meafured by $\frac{T}{H}$. The days on which fevers have been moft frequently obferved to terminate, are the 4th, 7th, 9th, 11th, 14th, 17th and 21ft.

A continual fever, in which the pulfe beats between 130 and 140 times in a minute is commonly mortal; it is dangerous when it beats between 120 and 130 times in a minute, although by a right conduct it may frequently be cured; but when it runs under 120 it is feldom mortal, when rightly treated.

In obſerving the manner of the paroxyſm of a perfect tertian, I have found the water to grow pale a little before the fit comes on; and to grow ſtill paler during the cold fit. As the fit comes on, the water grows higher coloured, and continues high coloured without any ſediment during the hot fit. A little after the body begins to ſweat, the urine lets fall a lateritious ſediment, and continues to do ſo for 17 or 18 hours after the fit is over; and then it returns to its natural colour, without any ſediment. It is to be obſerved that in all fevers the quickneſs of the pulſe always abates before there appears any ſeparation in the urine.

Before I explain the virtues and operations of Medicines upon the principles already laid down, I ſhall quote the following paſſages from the *Opticks*.

" Are not groſs bodies and *Light* convertible into one another, and may not " bodies receive much of their activity " from the particles of *Light* which enter their compoſition? For all fixed " bodies being heated emit *Light* ſo long " as

" as they continue sufficiently hot, and " *Light* mutually stops in bodies as often " as its Rays strike upon their parts.

" The changing of bodies into *Light*, " and *Light* into bodies, is very confor- " mable to the course of nature, which " seems delighted with transmutations. " Water, which is a very fluid tasteless " salt, she changes by heat into vapour, " which is a sort of Air, and by cold in- " to ice, which is a hard, pellucid, brittle, " fusible stone; and this stone returns in- " to water by heat, and vapour returns " into water by cold. Earth by heat be- " comes fire, and by cold returns into " earth. Dense bodies by fermentation " rarify into several sorts of Air, and this " Air by fermentation, and sometimes " without it, returns into dense bodies. " Mercury appears sometimes in the form " of a fluid metal, sometimes in the form " of a hard brittle metal, sometimes in " the form of a corrosive pellucid salt " called sublimate, sometimes in the form " of a tasteless, pellucid, volatile white " earth, called *mercurius dulcis*; or in

" that

" that of a red opake volatile earth, " called cinnabar; or in that of a red or " white precipitate, or in that of a fluid " ſalt; and in diſtillation it turns into va- " pour, and being agitated *in vacuo*, it " ſhines like fire. And after all theſe " changes it returns again into its firſt " form of mercury. Eggs grow from in- " ſenſible magnitudes, and change into a- " nimals; tadpoles into frogs; and worms " into flies. All birds, beaſts and fiſhes, " inſects, trees, and other vegetables, " with their ſeveral parts, grow out of " water and watry tinctures and ſalts, " and by putrefaction return again into " watry ſubſtances. And water ſtanding " a few days in the open Air, yields a " tincture, which (like that of mault) by " ſtanding longer yields a ſediment and " a ſpirit, but before putrefaction is fit " nouriſhment for animals and vegetables. " And among ſuch various and ſtrange " tranſmutations, why may not nature " change bodies into *Light*, and *Light* " into bodies?

" All bodies seem to be composed of
" hard particles: for otherwise fluids
" would not congeal; as water, oils, vi-
" negar, and spirit or oil of vitriol do by
" freezing; mercury by fumes of lead;
" spirit of nitre and mercury, by dissolv-
" ing the mercury and evaporating the
" flegm; spirit of wine and spirit of u-
" rine, by deflegming and mixing them;
" and spirit of urine and spirit of salt, by
" subliming them together to make sal-
" armoniac. Even the Rays of *Light* seem
" to be hard bodies; for otherwise they
" would not retain different properties
" in their different sides. And therefore
" hardness may be reckoned the property
" of all uncompounded matter. At least,
" this seems to be as evident as the uni-
" versal impenetrability of matter. For
" all bodies, so far as experience reaches,
" are either hard, or may be hardened;
" and we have no other evidence of uni-
" versal impenetrability, besides a large ex-
" perience without an experimental excep-
" tion. Now if compound bodies are so
" very hard as we find some of them to
" be,

" be, and yet are very porous, and consist
" of parts which are only laid together;
" the simple particles which are void of
" pores, and were never yet divided, must
" be much harder. For such hard par-
" ticles being heaped up together, can
" scarce touch one another in more than
" a few points, and therefore must be se-
" parable by much less force than is re-
" quisite to break a solid particle, whose
" parts touch in all the space between
" them, without any pores or interstices
" to weaken their cohesion.

" All these things being considered, it
" seems probable to me, that God in the
" beginning formed matter in solid, mas-
" sy, hard, impenetrable, moveable par-
" ticles, of such sizes and figures, and
" with such other properties, and in such
" proportion to space, as most conduced
" to the end for which he formed them;
" and that these primitive particles being
" solids, are incomparably harder than a-
" ny porous bodies compounded of them;
" even so very hard, as never to wear or
" break in pieces: No ordinary power

" being

"being able to divide what God himſelf
"made one in the firſt creation. While
"the particles continue entire, they may
"compoſe bodies of one and the ſame
"nature and texture in all ages: but
"ſhould they wear away, or break in
"pieces, the nature of things depending
"on them, would be changed. Water
"and earth compoſed of old worn par-
"ticles and fragments of particles, would
"not be of the ſame nature and texture
"now, with water and earth compoſed
"of entire particles, in the beginning.
"And therefore that nature may be laſt-
"ing, the changes of corporeal things are
"to be placed only in the various ſepara-
"tions and new aſſociations and motions
"of theſe permanent particles; com-
"pound bodies being apt to break, not in
"the midſt of ſolid particles, but where
"thoſe particles are laid together, and
"only touch in a few points."

I now proceed to give an account of the *virtues and operations of Medicines.* And firſt of *Water.*

WATER, according to Sir *Iſaac Newton*, is *a very fluid taſteleſs ſalt*. It is very fluid, from the ſmallneſs and weak coheſion of its particles of the *laſt compoſition*. Thoſe particles muſt be very ſmall, to paſs through the ſmalleſt veſſels of plants and animals; and from the weakneſs of their coheſion, they can contain but little *Light* in their compoſition. It has been ſhewn, that *Light* in bodies is the cauſe of the coheſion of their parts. In his paper *de natura acidorum*, Sir *Iſaac* calls that an acid which attracts much and is much attracted; which is the property of *Light*. And therefore according to him *Light* and acid are the ſame thing; or *Light* is an acid, and an acid *Light*.

The pureſt water is that which is lighteſt, or is leaſt impregnated with metallick, ſaline and earthy particles, all which are ſpecifically heavier than water. Rain water has been generally thought the lighteſt, and conſequently the pureſt and freeſt from contents. But Dr. *Hill* in his *Materia Medica* prefers ſnow-water. Which of the two ought to have the preference I cannot

cannot ſay, but I think this might be eaſily determined from their ſpecifick weights taken with an exact hydroſtatick ballance.

As to waters impregnated with metallick, ſaline, ſulphureous and terreſtrial particles, conſult thoſe who have written on mineral waters, particularly *Hoffman*, and Dr. *Short* who has given an account of the mineral waters in *England*. It is to be wiſhed, that thoſe who ſhall treat of common and mineral waters for the future, would give us both their ſpecifick weights and their degrees of heat. Dr. *Short* has given us the degrees of heat of ſeveral baths and ſprings in *England* by a thermometer, whoſe freezing point was 18 degrees, and the height to which the ſpirit roſe by the external heat of a body in health, was 67 degrees above the ball. If H be the number of degrees in this thermometer to which any of theſe waters raiſed the ſpirit above the ball, H—18 will expreſs the degree of heat of that water by this thermometer, and $\overline{H-18} \times \frac{12}{49}$

will expreſs the ſame degree of heat in the numbers of *Newton*'s ſcale.

Now as all vegetables and animals grow out of water and watry tinctures and ſalts, it may be neceſſary to underſtand the manner in which this is done, to give an account of the properties of accretion. In order to this, I made experiments with plants of mint of different weights and ages, and putting their roots into glaſſes filled with water, I took their perſpirations and growths in 8 days; and placed the reſult of the obſervations in this Table. It is to be obſerved, that there was a fourth glaſs of the ſame ſize with the other three, which had no plant in it.

Plants

Plants of mint of different weights.	A	B	C
I. Weights in grains - - - - - - - -	7	106	267
Perſpiration in eight days - - - - - -	90	530	906
Perſpiration in reſpect of weight - -	120	50	36
Growth in eight days - - - - - - - -	2	12	31
Growth in reſpect of weight - - - -	286	113	112
II. Weight in grains - - - - - - - -	12	80	203
Perſpiration in eight days - - - - - -	121	378	784
Perſpiration in reſpect of weight - -	101	47	38
Growth in eight days - - - - - - -	3	10	20
Growth in reſpect of weight - - - -	250	125	98
The plants (number II.) ſtript of all their leaves, but a few at the top	9	40	128
Perſpiration in eight days - - - - -	52	96	176
Perſpiration in reſpect of weight - -	57	24	14
Weights of the ſame ſtript of all the leaves - - - - - - - - - - - - -	7	34	121
Perſpiration in eight days - - - - -	6	22	134
Perſpiration in reſpect of weight - -	8½	6½	11

By

By this Table younger plants perſpire and grow more in proportion to their weights, than plants which are older. Conſequently, perſpiration and the growth of plants in reſpect of their weights, leſſen as plants grow older. In the three firſt plants, whoſe weights in grains were 7, 106, 267, that is, nearly as 1, 15, 38, perſpiration in eight days in reſpect of the weight, was above twice as great in the firſt plant as in the ſecond; and above three times as great in the firſt as in the third.

The caſe ſeems to be much the ſame in human bodies as in plants. For the diſcharges in proportion to the weight of the body, being as the number of pulſes in a given time, and the number of pulſes in a given time being two or three times as great in a very young child as in a grown body; the diſcharges in proportion to the weight of the body, will be two or three times as great in very young children as in grown bodies.

The great analogy between plants and animals, will appear farther by the following obſervations.

1. Hot beds accelerate the growth of plants, but ſuch plants are commonly ſhort lived. And human bodies grow faſter in hot countries than in cold, and for the moſt part are ſhorter lived.

2. Plants in hot beds are moſt injured by cold. And human bodies heated by exerciſe or ſpirituous liquors, are more injured by cold than others.

3. Cold watry plants, which thrive beſt in water, or in cool, ſhady and moiſt ground, are larger than hot and dry plants, which delight in dry ground expoſed to the ſun. If two colliflowers of equal age and bulk be planted, one in a ſun-ſhiny and the other in a ſhady place; the former will grow faſter, and blow much ſooner, but not acquire that magnitude which the latter attains to in a longer time. And human bodies, which are nouriſhed

riſhed by a cool, liquid or moiſt diet, are generally more bulky than thoſe which are nouriſhed by a warm and dry food.

4. Trees and plants grow leaſt in a hot ſummer, and moſt in a wet one. A wet ſummer gives them ſo much vigour, that they bear little fruit the ſummer following. A ſuper-abundance of juices hinders fruitfulneſs both in plants and animals. If a branch be too vigorous, it muſt be weakened by cutting to make it bear fruit. And thin weakly women are the greateſt breeders; and, from their fibres being weaker and capable of greater extenſion, have larger children, than women who are robuſt and ſtrong. The caſe is the ſame with regard to fruit-trees; for the weakeſt trees have the largeſt fruit. Of two equal branches, if one be upright, and the other be laid horizontal, the upright branch will grow three or four times as much in a given time as the horizontal one.

5. Fruits and flowers are made larger by lessening the number of bearing branches.

6. A certain top requires a certain root to nourish and support it, and consequently if the root be lessened the top must be so too. If the root be too big for the top, the top will throw out new shoots or much enlarge the old ones, and if the root be too little for the top, the top will wither for want of nourishmment. If more be taken away from the head or branches than from the root, its growth in a given time will be measured, by the excess of vigour of the root above the demand of the remaining top and branches. Leaves contribute much to the health and vigour of a tree, but if too thick, by covering the fruit, and taking off the sun, they hinder its ripening. In human bodies if the quantity of food be too little, the quantity and motion of the blood will lessen, and the skin grow pale; which answers to the withering of the top in trees, when the root, by which

 the

the nouriſhment is ſupplied, is too ſmall for it.

7. A weak tree muſt be pruned ſhort to invigorate the new ſhoots, and a ſtrong tree muſt be pruned long to weaken them. A tree decaying and not to be recovered by common watering, *viz.* by pouring a quantity of water all at once, has been reſtored by conveying water to it by drops from the end of a liſt or rope, whoſe other end is put into a veſſel filled with water. And grievous diſeaſes have been cured by leſſening the quantity of food. This was the caſe of *Cornaro.*

8. Trees in a wet ſoil are moſt ſubject to gum and canker; and men who have moiſt and wet habitations are ſubject to diſeaſes, eſpecially if there be much wood about them; for woody countries are found by experience to be unhealthy. *Ireland* which formerly abounded much with wood and bogs, was much more unhealthy than it is at preſent, a great part of the wood being cut down, and many of the bogs

bogs drained. The great draught of watry moiſture from the earth by large woods, will make the atmoſphere to abound with watry vapours; and thoſe vapours will in ſome meaſure be rendered effete, the water, as it circulated through the veſſels of the trees, having given up its acid or *Light* to the denſer and more ſtrongly attracting ſides of the veſſels; in like manner as Air becomes effete and unfit to ſupport Life, Fire and Flame, when it is deprived of its acid ſpirit by paſſing through the lungs of animals, and by ſupporting fire and flame; as I have ſhewn in *Prop.* 24. of the *Animal Oeconomy*. All this is evident from *Light* being the cauſe of coheſion as has been ſhewn, and from the coheſion of the component particles of the fibres growing ſtronger as the fibres increaſe in denſity and magnitude.

9. By this table we ſee how greatly the leaves of plants and trees contribute to their growths.

As I may have occaſion in the progreſs of this work to conſider Heat, Fire, Flame and ſome properties of *Light* more particularly than I have hitherto done, I ſhall beg leave to tranſcribe the following queries of Sir *Iſaac Newton*'s *Opticks*.

" Do not all fix'd bodies when heated
" beyond a certain degree, emit *Light*
" and ſhine, and is not this emiſſion per-
" formed by the vibrating motions of their
" parts? And do not all bodies which
" abound with terreſtrial parts, and e-
" ſpecially with ſulphureous ones, emit
" *Light* as often as thoſe parts are ſuffi-
" ciently agitated; whether that agitation
" be made by heat, or by friction, or per-
" cuſſion, or putrefaction, or by any vi-
" tal motion, or any other cauſe? As for
" inſtance; ſea water in a raging ſtorm;
" quickſilver agitated in *vacuo*; the back
" of a cat, or neck of a horſe obliquely
" ſtruck or rubbed in a dark place; wood,
" fleſh and fiſh while they putrefy; va-
" pours ariſing from putrefy'd waters, u-
" ſually call'd *ignes fatui*; ſtacks of moiſt
" hay or corn growing hot by fermenta-
tion;

" tion; glow-worms and the eyes of ſome
" animals by vital motions; the vulgar
" *phoſphorus* agitated by the attrition of
" any body, or by the acid particles of
" the Air; ambar and ſome diamonds by
" ſtriking, preſſing or rubbing them;
" ſcrapings of ſteel ſtruck off with a flint;
" iron hammer'd very nimbly till it be-
" come ſo hot as to kindle ſulphur thrown
" upon it; the axle-trees of chariots tak-
" ing fire by the rapid rotation of the
" wheels; and ſome liquors mix'd with
" one another whoſe particles come toge-
" ther with an impetus, as oil of vitriol
" diſtilled from its weight of nitre, and
" then mix'd with twice its weight of
" oil of anniſeeds. So alſo a globe of
" glaſs about 8 or 10 inches in diameter,
" being put into a frame where it may be
" ſwiftly turn'd round its axis, will in
" turning ſhine where it rubs againſt the
" palm of ones hand apply'd to it: And
" if at the ſame time a piece of white pa-
" per or a white cloth, or the end of ones
" finger be held at the diſtance of about
" a quarter of an inch or half an inch

" from

" from that part of the glaſs where it is " moſt in motion, the electrick vapour " which is excited by the friction of the " glaſs againſt the hand, will by daſhing " againſt the white paper, cloth or finger, " be put into ſuch an agitation as to emit " *Light*, and make the white paper, cloth " or finger, appear lucid like a glow-" worm; and in ruſhing out of the glaſs " will ſometimes puſh againſt the finger " ſo as to be felt. And the ſame things " have been found by rubbing a long and " large cylinder of glaſs or ambar with a " paper held in ones hand, and continuing " the friction till the glaſs grew warm.

" Is not fire a body heated ſo hot as to " emit *Light* copiouſly? For what elſe is " a red hot iron than fire? And what elſe " is a burning coal than red hot wood?

" Is not flame a vapour, fume or ex-" halation heated red hot, that is, ſo hot " as to ſhine? For bodies do not flame " without emitting a copious fume, and " this fume burns in the flame. The " *ignis fatuus* is a vapour ſhining without " heat, and is there not the ſame diffe-

" rence

" rence between this vapour and flame,
" as between rotten wood ſhining with-
" out heat and burning coals of fire? In
" diſtilling hot ſpirits, if the head of the
" ſtill be taken off, the vapour which aſ-
" cends out of the ſtill will take fire at
" the flame of a candle, and turn into
" flame, and the flame will run along the
" vapour from the candle to the ſtill.
" Some bodies heated by motion or fer-
" mentation, if the heat grow intenſe,
" fume copiouſly, and if the heat be great
" enough the fumes will ſhine and be-
" come flame. Metals in fuſion do not
" flame for want of a copious fume, ex-
" cept ſpelter, which fumes copiouſly,
" and thereby flames. All flaming bo-
" dies, as oil, tallow, wax, wood, foſſil
" coals, pitch, ſulphur, by flaming waſte
" and vaniſh into burning ſmoke, which
" ſmoke, if the flame be put out, is very
" thick and viſible, and ſometimes ſmells
" ſtrongly, but in the flame loſes its ſmell
" by burning, and according to the na-
" ture of the ſmoke the flame is of ſeve-
" ral colours, as that of ſulphur blue, that
" of

" of copper open'd with ſublimate green,
" that of tallow yellow, that of camphire
" white. Smoke paſſing through flame
" cannot but grow red hot, and red hot
" ſmoke can have no other appearance
" than that of flame. When gun-pow-
" der takes fire, it goes away into flam-
" ing ſmoke. For the charcoal and ſul-
" phur eaſily take fire, and ſet fire to the
" nitre, and the ſpirit of the nitre be-
" ing thereby rarified into vapour, ruſhes
" out with exploſion much after the man-
" ner that the vapour of water ruſhes out
" of an Æolipile; the ſulphur alſo being
" volatile is converted into vapour, and
" augments the exploſion. And the acid
" vapour of the ſulphur (namely that
" which diſtils under a bell into oil of
" ſulphur,) entring violently into the fix'd
" body of the nitre, ſets looſe the ſpirit of
" the nitre, and excites a greater fermen-
" tation, whereby the heat is farther aug-
" mented, and the fix'd body of the nitre
" is alſo rarified into fume, and the ex-
" ploſion is thereby made more vehement
" and quick. For if ſalt of tartar be

" mix'd

" mix'd with gun-powder, and that mixture be warm'd till it takes fire, the explosion will be more violent and quick than that of gun-powder alone; which cannot proceed from any other cause than the action of the vapour of the gun-powder upon the salt of tartar, whereby that salt is rarified. The explosion of gun-powder arises therefore from the violent action whereby all the mixture being quickly and vehemently heated, is rarified and converted into fume and vapour: which vapour, by the violence of that action, becoming so hot as to shine, appears in the form of flame.

" Do not great bodies conserve their heat the longest, their parts heating one another, and may not great dense and fix'd bodies, when heated beyond a certain degree, emit *Light* so copiously, as by the emission and re-action of the *Light*, and the reflexions and refractions of its Rays within their pores to grow still hotter, till it comes to a certain period of heat, such as is that

" of the sun? And are not the sun and
" fix'd stars great earths vehemently hot,
" whose heat is conserved by the great-
" ness of the bodies, and the mutual ac-
" tion and re-action between them, and
" the *Light* which they emit, and whose
" parts are kept from fuming away, not
" only by their fixity, but also by the
" vast weight and density of the atmo-
" spheres incumbent upon them, and ve-
" ry strongly compressing them, and con-
" densing the vapours and exhalations
" which arise from them? For if water
" be made warm in any pellucid vessel
" emptied of air, that water in the *va-*
" *cuum* will bubble and boil as vehe-
" mently as it would in the open air in
" a vessel set upon the fire till it con-
" ceives a much greater heat. For the
" weight of the incumbent atmosphere
" keeps down the vapours, and hinders
" the water from boiling, until it grow
" much hotter than is requisite to make
" it boil *in vacuo*. Also a mixture of
" tin and lead being put upon a red
" hot iron *in vacuo* emits a fume and

" flame,

" flame, but the ſame mixture in the
" open air, by reaſon of the incumbent
" atmoſphere, does not ſo much as emit
" any fume which can be perceived by
" ſight. In like manner the great weight
" of the atmoſphere which lies upon the
" globe of the ſun may hinder bodies
" there from riſing up and going away
" from the ſun in the form of vapours
" and fumes, unleſs by means of a far
" greater heat than that which on the
" ſurface of our earth would very eaſily
" turn them into vapours and fumes. And
" the ſame great weight may condenſe
" thoſe vapours and exhalations as ſoon
" as they ſhall at any time begin to aſ-
" cend from the ſun, and make them
" preſently fall back again into him, and
" by that action increaſe his heat much
" after the manner that in our earth the
" air increaſes the heat of a culinary fire.
" And the ſame weight may hinder the
" globe of the ſun from being diminiſh-
" ed, unleſs by the emiſſion of *Light*,
" and a very ſmall quantity of vapours
" and exhalations."

It is to be obſerved, that the particles of acids, which Sir *Iſaac Newton* ſpeaks of in his *de naturâ acidorum*, are not the ſmall and uncompounded particles of *Light*, but the great and compounded particles of ſalts formed out of water and earth united by the power of *Light* adhering to the ſurfaces of the particles of water and earth of the laſt compoſition. *Light* does the office of a medium between the earth and common water, for making ſalts diſſolvable in water; and Sir *Iſaac* ſays an acid does the ſame office; and therefore *Light* and acid expreſs the ſame thing; and ſalts have all their acid from the *Light* which enters their compoſition. Hence, thoſe ſalts attract both water and earth moſt ſtrongly, which contain moſt *Light*, that is moſt acid. But ſalts which have acquired *Light* from fire attract both water and earth more ſtrongly than they did before; as may appear by the following experiments.

Salt of tartar when expoſed to the air, runs *per deliquium*, by an attraction be-

tween

tween the particles of the ſalt, and the particles of the water which float in the air in the form of vapours. And the water which alone diſtils with a lukewarm heat, will not diſtil from ſalt of tartar without a great heat, which argues a ſtrong attraction of this ſalt.

Oil of vitriol attracts water very ſtrongly, and by the ſtrength of its attraction it draws a good quantity of water out of the air, and in diſtillation lets go the water very difficultly.

Water and oil of vitriol poured ſucceſſively into the ſame veſſel grow very hot in the mixing, which argues a great motion in the parts of the liquors, and that motion argues that the parts of the two liquors in mixing coaleſce with violence, and ruſh towards one another with an accelerated motion.

Aqua fortis, or ſpirit of vitriol poured upon filings of iron, diſſolves the filings with a great heat and ebullition, which heat and ebullition are effected by a violent motion of the parts, which motion argues that the parts of the liquor

ruſh

rush towards the parts of the metal with violence, and run forcibly into its pores till they get between its outmost particles and the main mass of the metal, and surrounding those particles loosen them from the main mass, and set them at liberty to float off into the water, which they will do by the repulsive power of the particles thus separated and thrown by heat beyond the reach of attraction. And the acid particles which alone would distill with an easy heat, will not separate from the particles of the metal without a very violent heat, which argues a very strong attraction between them.

Spirit of vitriol poured upon common salt or salt-petre makes an ebullition with the salt and unites with it, and in distillation the spirit of the common salt or salt-petre comes over much easier than it would do before, and the acid part of the spirit of vitriol stays behind; this argues that the fix'd alcaly of the salt attracts the acid spirit of the vitriol more strongly than its own spirit and not being able to hold both, lets go its own.

When

When oil of vitriol is drawn off from its weight of nitre, and from both the ingredients a compound ſpirit of nitre is diſtilled; and when two parts of this ſpirit are poured on one part of oil of cloves or caraway ſeeds, or of any ponderous oil of vegetable or animal ſubſtances, or oil of turpentine thickened with a little balſam of ſulphur, the liquors grow ſo hot in mixing as preſently to ſend up a burning flame: This very great and ſudden heat argues, that the two liquors mix with violence, and that their parts in mixing run towards one another with an accelerated motion, and claſh with the greateſt force. For the ſame reaſon it is that well rectified ſpirit of wine poured on the ſame compound ſpirit flaſhes; and that *pulvis fulminans* compoſed of ſulphur, nitre, and ſalt of tartar, goes off with a more ſudden and violent exploſion than gun-powder, the acid ſpirits of the ſulphur and nitre ruſhing towards one another, and towards the ſalt of tartar with ſo great violence, as by the ſhock to turn the whole at once

into

into vapour and flame. Where the dissolution is slow, it makes a slow ebullition and a gentle heat; and where it is quicker, it makes a greater ebullition with more heat; and where it is done at once, the ebullition is contracted into a sudden blast or violent explosion, with a heat equal to that of fire and flame. So when a drachm of the above mentioned spirit of nitre was poured upon half a drachm of oil of caraway seeds *in vacuo*, the mixture immediately made a flash like gunpowder, and burst the receiver, which was a glass six inches wide and eight inches deep.

The gross body of sulphur powder'd, with an equal weight of iron filings, and a little water made into paste, acts upon the iron, and in five or six hours grows too hot to be touched, and emits a flame. By dissolving flowers of sulphur in oil of turpentine, and distilling the solution, it is found that sulphur is composed of an inflamable thick oil or fat bitumen, an acid salt, a very fix'd earth, and a little metal. The three first were

found

found not much unequal to one another, the fourth in ſo ſmall a quantity as ſcarce to be worth conſidering. The acid ſalt diſſolved in water is the ſame with oil of ſulphur *per campanam*, and of the ſame nature with oil of vitriol, which abounding much in the bowels of the earth, and particularly in markaſites, unites itſelf to the other ingredients of the markaſite, which are bitumen, iron, copper and earth, and with them compounds alume, vitriol and ſulphur. With the earth alone it compounds alume; with the metal alone, or metal and earth together, it compounds vitriol; and with the bitumen and earth it compounds ſulphur. Whence it comes to paſs, that markaſites abound with thoſe three minerals.

" By theſe experiments compared with " the great quantity of ſulphur with " which the earth abounds, and the " warmth of the interior parts of the " earth, and hot ſprings, and burning " mountains, and with damps, mineral " coruſcations, earthquakes, hot ſuffocat" ing exhalations, hurricanes and ſpouts;

"we may learn that ſulphureous ſteams
"abound in the bowels of the earth and
"ferment with minerals, and ſometimes
"take fire with a ſudden coruſcation and
"exploſion; and if pent up in ſubterra-
"neous caverns, burſt the caverns with
"a great ſhaking of the earth, as in
"ſpringing of a mine. And then the
"vapour generated by the exploſion, ex-
"piring through the pores of the earth,
"feels hot and ſuffocates, and makes
"tempeſts and hurricanes, and ſome-
"times cauſes the land to ſlide, or the
"ſea to boil, and carries up the water
"thereof in drops, which by their weight
"fall down again in ſpouts. Alſo ſome
"ſulphureous ſteams, at all times when
"the earth is dry, aſcending into the
"air, ferment there with nitrous acids,
"and ſometimes taking fire cauſe light-
"ening and thunder, and fiery meteors.
"For the air abounds with acid vapours
"fit to promote fermentations, as ap-
"pears by the ruſting of iron and cop-
"per in it, the kindling of fire by blow-
"ing,

" ing, and the beating of the heart by
" means of respiration."

Iron requires more *aqua fortis* or spirit of vitriol to dissolve it, than any of the other metals. And of all metals, iron is dissolved most easily, and next after iron, copper. Iron corroded with a little acid turns into rust, which is an earth tasteless and indissolvable in water, and this earth imbibed with more acid becomes a *sal martis* which is dissolvable in water, and has an astringent and somewhat a sweetish taste. Acids by adhering to the particles of the iron lose much of their activity, and their taste in *sal martis* becomes much milder than before.

Six troy ounces of water the cold being just taken off, were put into a bolt-head, holding three quarts, with two ounces of spirit of vitriol, and one ounce of fresh filings of iron. The mixture instantly began to bubble, grow hot, and emit a smoke, which smoke took fire at the flame of a candle held to it, and went off with an explosion equal

to that of a ſmall piſtol. The ſame happened on repeating the experiment; but the exploſion grew leſs, as the quantity of ſmoke leſſened from a diminution of the ebullition and heat. When the ebullition was nearly over, the liquor was filtered through cap-paper into a clear glaſs, and in a little time it let fall a fine *ſal martis* to the bottom of the glaſs.

Mr. *Geoffroy* has given the following very accurate account of iron.

" —— Scobs ferrea in acervum con-
" geſta & aquâ humectata adeò incaleſ-
" cit, ut, ſi ſulphur admoveatur, flam-
" mam concipiat, modò magna ſit li-
" maturæ congeſtæ copia. ——

" Hoc metallum ab acidis quibuſcun-
" que diſſolvitur; intactum verò relin-
" quitur à ſalibus alcalicis.

" Limatura ferri in flammam injecta
" accenditur, & ſcintillas vividas ac ruti-
" lantes excitat. Æquales ſcobis ferreæ ac
" nitri portiones in crucibulum candens
" conjectæ, mox quidem ebulliunt, & fu-
" mum copioſum ac fœtidum emittunt:
" tandem deflagrant cum fulguratione.

" Scobs

"Scobs ferrea in ſpiritum ſalis vel vi-
" trioli injecta vehementem excitat ef-
" ferveſcentiam cum copioſo fumo pror-
" ſus ſulphureo, cui ſi candela accenſa ad-
" moveatur, ſtatim flammam concipit ſæ-
" pe cum fragore & vaſorum diſruptione.

" Ferrum foco lentis vitreæ majoris,
" ſub radiis ſolaribus admotum ſupra
" tegulam, ſtatim liqueſcit, fumos emit-
" tit copioſos, ac tandem in materiam
" friabilem, & ſubnigram convertitur,
" non ampliùs ductilem & ſemi-vitrifi-
" catam. At verò ferrum eidem foco
" ſuper carbones expoſitum liqueſcit, &
" paulò poſt in ſcintillas totum diffun-
" ditur, & evaneſcit. Idem accidit ferro
" in tegulâ ſemi-vitrificato, dummodò
" ſub radiis ſolaribus è tegulâ in carbo-
" nes transferatur. Nam priſtinam me-
" talli formam, ſplendorem nempe &
" ductilitatem recuperat, & poſtea to-
" tum in ſcintillas diſſipatur.

" Ex his liquet ferrum bituminoſæ
" ſubſtantiæ portionem non mediocrem
" continere; quæ cum ſale vitriolico
" conſociata, tantâ terræ metallicæ vi-
treſcibilis

" trescibilis copiâ implicatur & irretitur;
" ut nonnisi difficillimè cum nitro de-
" flagrationem & fulgurationem susci-
" piat. Nec parvam esse salis vitriolici
" copiam intelligitur ex ferri solubilitate
" in aquâ simplici, ex hujus aquæ la-
" pore, & ex ferreæ scobis aquâ made-
" factæ incalescentiâ, quæ quidem à sa-
" lium in terram metallicam actione
" oritur. Quoddam tamen intercedit
" discrimen inter sulphuream carbonum
" substantiam, & ferri sulphur; quan-
" doquidem ferrum sulphure carbonum
" imbutum solarium radiorum in foco
" totum in scintillas dissiliat.

" Ferrum itaque ex substantiâ bitumi-
" nosâ, seu principio inflammabili, sale
" vitriolico & terrâ quâdam vitrescibili,
" conjunctis quidem, sed non intimè uni-
" tis, componitur. Et reverâ si argilla,
" terra nempe vitrescibilis & vitriolica
" cum substantiâ quâcunque inflammabili
" ignis ope consocietur, fit ferrum; quod
" etiam fieri solet in deflagratione quo-
" rumcunque corporum inflammabilium,
" & in eorum cineribus magnetis ope

" detegitur,

"detegitur, licèt ante deflagrationem in
"hiſce ſubſtantiis vel tenuiſſimè tritis
"nulla ferri portiuncula deprehendere-
"tur."

The vitriolick acid united with the earthy alcali of nitre, compounds the *nitrum vitriolatum* and *ſal polychreſtus*. The ſame acid united with the alcali of ſea-ſalt, compounds the *ſal catharticus* GLAUBERI. And the ſame acid united with either iron or copper, compounds the vitriol of iron, or vitriol of copper.

A paſte made with freſh filings of iron and common water will ſoon grow hot; and the heat will be much greater, if, inſtead of water, the paſte be made with vinegar.

The teſtaceous powders mixed with acids, do in the very mixing riſe up in bubbles, and appear to be a heap of froth. But though the attraction between theſe powders and acids be ſtrong, yet it is ſoon over, on which account but little heat attends the mixing of theſe powders with acids. On mixing ſeveral of theſe powders with ſpirit of vitriol, and taſting

tasting the mixtures after the ebullition was over, I found the acidity to be quite destroyed in all of them, without almost any stipticity that could be perceived by the taste.

From these experiments we learn the virtues and operations of *iron* and its *several preparations*, and also of the *testaceous powders*, on the fibres and fluids of human bodies.

The whole virtue of iron consists in destroying acids, in giving heat and motion to the blood and juices; and in strengthening the fibres, and in giving a tenacity and consistence to the fluids. The two first are effected by *fresh filings of iron*, and the two last by *sal martis*, or some weak preparation of iron which has lost its heating quality by its sulphur being destroyed by acids. But then if it be considered, that iron deprived of its sulphur by acids, causes sickness and vomiting, when given in a sufficient quantity; and that frequent vomiting very safely and powerfully removes obstructions, and gives heat and motion to the blood;

blood; and on the other hand, that freſh filings have cauſed hæmorrhages where there have been weak and obſtructed bowels; it will be ſafer, and therefore more adviſeable in moſt caſes to uſe *ſal martis*, or ſome weak preparation of iron, than freſh filings. Iron prepared with tartar made into pills with common water, twelve out of a drachm, has been found very effectual in curing obſtructions among the common people, in pale, cold and phlegmatick habits of body; two pills being taken every morning and evening, with exerciſe, for a fortnight or three weeks: and in caſe of great coſtiveneſs under this courſe, a pill made of two or three grains of ſuccotorine aloes, or ſo much as ſhall be juſt ſufficient to prevent that complaint, muſt be taken at night going to bed.

Acids in the ſtomachs of children, and young weak bodies may be deſtroyed by the teſtaceous powders; and heat and motion be given to the blood by vomits.

I have from experiments ſhewn the effects of vomits on the motion of the

blood, and I ſhall now by the following CASES ſhew their great uſefulneſs in curing diſeaſes.

Caſe 1. A man aged above thirty years, of a thin, ſpare and very ſcorbutick habit of body, ſubject to frequent returns of a diſcharge of blood from the lungs, was in a great meaſure freed from the returns of that diſcharge for eight years before he died, by the frequent uſe of vomits. At firſt he took half a drachm, and, after ſome time, two ſcruples of *Ipecacuanha*, with ſix or ſeven quarts of ſtrong chamomile tea to promote the operation. He took theſe vomits three times a week, except when he had taken cold, to which he was very ſubject; for then he took a vomit for two or three nights together, which always relieved him. He could not be hindered from going into the country every ſummer, though he conſtantly got cold on his return to town in autumn, which he always got rid of by vomits. He ſometimes, by the advice of his friends, took tar-

tar-water, which conſtantly brought on a ſpitting of blood; from which he was as conſtantly freed by vomits.

Caſe 2. A man of a middle age, who frequently for twelve years had large diſcharges of blood from his lungs, and had tried many things without any laſting benefit; was at laſt freed from a return of that diſcharge, by a courſe of vomits. And if at any time he was threatened with a diſcharge, by ſymptoms which uſed to appear a few days before it happened, he always prevented it by a vomit. He uſed vomits with ſucceſs for eight years, and then died of a true *Phthiſis Pulmonum*.

Caſe 3. A young man aged about twenty years, from a pleuretick fever grew hectick, and ſpit up blood and corruption ſo very fetid ſometimes as ſcarcely to be endured by thoſe who were near him. He vomited with chamomile-tea once a day for a whole year; and twice a day for ſix weeks of that

 time,

time, on account of a more than ordinary difficulty of breathing. By thefe vomits, and fometimes drinking affes milk in the morning, and always claret moderately with flefh meat at dinner, and riding, the fymptoms abated, (though they were never wholly removed) and he fometimes gathered a little flefh. Under thefe circumftances, he went to the fouth of *France*, and after he had been there for fome time, he fpit blood again in a larger quantity than ufual; to check which difcharge, his Phyficians ordered fmall and repeated bleedings, pectoral drinks, and a cooling incraffating diet, which had no other effect than to weaken him. He returned home, and in a fhort time died.

Cafe 4. A boy aged eleven years, remarkable for the robuftnefs of his conftitution, and the greatnefs of his appetite, had, after a dangerous and irregular meafles, an apoftemation formed in the lungs, from which he was entirely freed in about two months by the following method.

method. He took a vomit two nights ſucceſſively, and intermitted the third. Two or three times a day he took two ſpoonfuls of a ſolution of equal parts of *Balſam. Gilead. & Tolut.* He was allowed at dinner any plain meat, with ſack and water, and a glaſs or two of claret after dinner. Under this method, all the ſymptoms, *viz.* hectick fever, night ſweats, and colliquative Diarrhæa, *&c.* abated ſenſibly, and the diſcharge of purulent matter, which at firſt was not leſs than three or four ounces in twenty-four hours, gradually leſſened, and at laſt entirely ceaſed. It was obſerved, that he ſlept better, and was in all reſpects better the nights he took the vomit, than the nights he omitted it.

The ſame boy at the age of fourteen, from violent exerciſe fell into a fever, attended from the very firſt attack with a laborious and difficult reſpiration, a dry cough, and an acute pain in the head. Theſe ſymptoms, notwithſtanding large evacuations by bleeding, vomiting and bliſtering,

bliſtering, terminated in an abſceſs of the lungs, which began to diſcharge itſelf by ſpitting on the one and twentieth day.

He now diſcharged very near half a pint of purulent matter in twenty-four hours, and raved inceſſantly. The ſame method, which formerly reſtored him, was again purſued, and with the ſame ſucceſs, and in about three months time he was perfectly reſtored to health. In this illneſs he had a ſecond collection of matter, occaſioned, as I judge, by his diſcontinuing the uſe of the vomits too ſoon, which made it neceſſary to repeat the vomits every night for a month. He has continued perfectly well for above theſe three months.

Caſe 5. A man about thirty years of age, who was much waſted by a pleuriſy, and reduced to ſuch a degree of weakneſs as not to be able to turn in his bed, was contrary to the opinion of his Phyſician and his friends, reſtored to health, by taking a vomit of chamomile-tea every day for about two months. By the

the firſt three or four vomits, though he bore the operation well, he found no ſenſible benefit; but from that time he daily grew better, and recovered. He was allowed to eat any freſh fleſh meat he had a mind to, and drink moderately of claret.

Caſe 6. When I attended Dr. *Stevens*'s Hoſpital in the year 1737, I took in five or ſix men, who, from pleuriſies, had a hectick fever, attended with a ſpitting of purulent matter, and night ſweats: and ſent them all out free from thoſe complaints, by vomiting them every day, and allowing them the fleſh diet of the houſe.

Caſe 7. An Apothecary, very ſubject to pleuriſies, diſcharged, when I ſaw him, a vaſt quantity of a thin, bloody, purulent matter, that was extremely offenſive to thoſe about him. By vomiting once or twice a day, eating fleſh meat, chiefly beef or mutton, and daily drinking a pint of claret, the ſymptoms abated; and

and he was able in a little time to go abroad in the middle of the day, and attend businefs. In fome months he was able to ride to the *North*, to vifit his friends. What he fpit up foon loft its offenfive fmell, and he lived two years from the time I firft faw him, till the lobe affected was deftroyed, and the matter had got to the fpinal marrow. For at laft he was feized with a palfy, as game-cocks are, when they are wounded in the neck, through the fpine.

Cafe 8. A man of a middle age, after he had been cut for a fiftula, went to *Spa*, and drank the waters. In fome time after he came home: I vifited him; and found him labouring under a great cough, and a fpitting of much purulent matter, fo very fetid, as fcarcely to be born by thofe who were near him. By taking a vomit every fecond day, and drinking mead for his conftant drink, his cough abated, and the matter he fpit up foon loft its offenfive fmell. And had he perfifted in this courfe, which kept

him

him tolerably well for a conſiderable time, he might have lived for ſome years, but by neglecting it a whole ſummer, he ſickened and died. It is to be obſerved, that on the vomiting days, in which he had eat beef or mutton for dinner, what he threw up by his vomit was always digeſted; but it was otherwiſe when he dined upon chicken, which was always thrown up undigeſted.

Caſe 9. A man of about twenty-ſix or twenty-ſeven years of age, was in the year 1732, after a fever, ſeized with a ſpitting of blood, which continued on him about two years. During this time he had a cough, his ſpittle was tinged with blood, and of a brick colour; and upon going out into the cold, or uſing any violent exerciſe, the blood came away clear, but in no large quantity. This kept him low, and he grew emaciated. In the month of *June* or *July*, 1734, the accident of a jolt in a coach brought on the ſpitting with violence, which conti-

nued for half a quarter of an hour, during which time, every half minute he threw up large mouthfuls of blood, with a little cough. He was then bled in the arm, and the ſpitting of blood ceaſed: but returned again towards the next morning with greater violence, and he threw up a large quantity. He was bled in the arm again, but the ſpitting did not ceaſe: then the Surgeon propoſed his taking *Eaton*'s ſtyptick; but this was diſapproved of, and a vomit of *Ipecacuanha* was ordered. At the beginning of the operation there came up a large quantity of black extravaſated blood, and afterwards ſome blood more clear. But towards the end of the operation, the diſcharge of blood ceaſed, and the water came up clean. He took the like vomit on the following day, and thrice a week for a fortnight or three weeks afterwards, and twice a week for two or three weeks more. During this time he drank *Spa*-water, and his diet was roaſt mutton, and white meats, and a pint of claret every day.

day. He is now alive and in good health, and never had any ſpitting of blood ſince the taking of the firſt vomit: and when he does happen to take cold, he is not ſo apt to be affected with a cough, as he uſed to be before.

Caſe 10. A woman had her womb much injured in child-birth; the perſon who delivered her having endeavoured, by miſtake, inſtead of the *placenta*, to bring away the womb. On this ſhe had ſo great a diſcharge of blood, that ſhe was almoſt continually fainting, and thought to be in a dying way. To leſſen the motion of the blood to the injured womb, by increaſing its motion through the other parts of the body, ſhe, at firſt almoſt continually, excited a reaching or vomiting, by a feather, her finger, or chamomile-tea. When the diſcharge of blood was abated, ſhe took the chamomile-tea only every ſecond day for many months, and recovered. She went into the country, and at the end of five years returned to town, very

well, only very pale; had the *catamenia* regular, in a moderate quantity, and without pain.

Case 11. A ſtrong man, who had driven a one-horſe hackney chair for about a year, was at the age of thirty-one, afflicted with the piles. A leech applied at the beginning gave ſome eaſe; however, they continued two years, during the laſt of which, bloody, corrupted and fetid ſtools were diſcharged, ſo that the piles terminated in a dyſentery, and ſix fiſtulous ulcers near the *anus*, which extended up the back as far as the region of the kidneys. He had at the ſame time a cough, a pain in the ſtomach, an entire loſs of appetite, pains in the groin, which were attended with an obſtruction of urine, and a pain from that part of the back where the fiſtulous ulcers terminated, ſhooting to the upper part of his neck, ſo that he could not ſtand ſtraight. In April, which was about a month after he was troubled with theſe complaints, he began to vomit with

chamomile-

chamomile-tea, which he did two or three times a day, for about eight weeks. In three or four days after first taking the vomits, he began to have profuſe ſweats, which were checked by bathing four or five times in ſpring-water; and his appetite was reſtored by drinking water in which wormwood had been ſteeped. About the month of June, he entered into a courſe of ſea-water, which he drank daily in a greater or leſſer quantity for a year and a half. At firſt he took a quarter of a pint of it twice a day: This promoted urine, and increaſed his appetite, and when he had any diſorder or pain in his ſtomach, he took a pint or a pint and a half, which quantity purged him, and took off the pain. In about a year's time his complaints were removed, the fiſtulous ulcers in his back all dried up, and he recovered good health, in which he has continued ever ſince, being two years, but does not follow the ſame buſineſs.

Case 12. A man, who had been cut for a fiſtula, was reduced to very great weakneſs by a dyſentery, attended with exceeding great and fetid ſtools of blood and matter. For the firſt week after I ſaw him, he drank largely of chicken-broth, to the quantity of ſix or ſeven quarts in twenty-four hours. For the ſecond week, he took a vomit of chamomile-tea every day, drank largely of a mixture of claret and water, eat chicken at dinner, and took an opiate at night. After that, he removed into better air, drank aſſes-milk in a morning, eat light meat, and drank wine and water and plain wine at dinner, ſtill continuing his vomits, but not ſo frequently as before. And thus by degrees he recovered.

Caſe 13. A man of a very phlegmatick habit of body, at the age of about forty-four, on taking cold in *London* was ſeized with an intermitting fever, which in ſome time became a regular quartan. This fever was cured by the bark taken in large quantities, and for a conſiderable

time.

time. In about four months from the beginning of the fever, he had an ill-conditioned pimple between his ſhoulders, attended with great inflammation all around it. This pimple and inflammation were followed by a *Diabetes*, which gave occaſion to his Phyſician to call the pimple a *diabetick carbuncle*. For this he took large quantities of crude alum, with *Mynſyct*'s tincture of ſteel, which ſtopped the *Diabetes*, on which the fever left him. He had four returns of a *Diabetes*, occaſioned in the ſame manner, which were ſtopped by crude alume, or crude antimony, bark, rhubarb, and *Briſtol*-water drank upon the ſpot. This method of curing the *Diabetes*, was ſucceeded by violent cholicks, which upon his coming to *Ireland*, were eaſed by opium and waſhing-vomits, and entirely cured by a milk-diet. To prevent a return of theſe carbuncles, and the *Diabetes* which uſed to attend them, he vomited every other day, for ſeven weeks together, with two ſcruples of *Ipecacuanha*, and two grains of emetick tartar; which

which hindered a carbuncle in his arm from growing bad, and entirely prevented the *Diabetes* which uſed to attend it: ſo that afterwards he never had any return of that complaint. He continued tolerably well by taking a vomit now and then, and always drinking a few glaſſes of wine with his meat, till the laſt great froſt in the year 1739, when he went to the *North* to viſit a friend, where he walked ſome miles every morning in a very cold air. This exerciſe, very improper for a perſon of his conſtitution, gave him a true aſthma, as I found when he came to town, by obſerving the motion of the muſcles of the abdomen in reſpiration. After he had been ſome days in town, he was ſeized with an inflammation of the lungs, which was carried off in ſeven days, by bleeding once, and vomiting once or twice a day with chamomile-tea. His legs and feet were generally cold, from the ſlow motion of his blood; and he had ill-conditioned ulcers in his legs for three or four months before he died,

which

which happened about a year after his coming from the *North*, and about eight years after his coming to *Ireland*. He always uſed too low a diet, and the motion of his blood was too low; it was raiſed a little by the vomits and wine, but was ſtill below the ſtandard of good and uninterrupted health.

Caſe 14. A perſon, between the ages of ſeven and eleven, had a jaundice, and was ſubject to cholicks and bleeding at the noſe. As he grew up, thoſe diſorders abated, and rarely returned, unleſs they were brought on by ſome accident. About the age of fourteen he got the itch, and ſoon after had a fever, which waſted him to a ſkeleton. After his recovery from the fever, he broke out moſt violently; for which he uſed brimſtone and a quickſilver girdle. Soon after he was ſeized with the ſmall-pox, which were diſtinct and favourable. At the beginning of this diſtemper the girdle was taken off, the itch ſtruck in, and he bled at the noſe. As ſoon as he was

well,

well, the itch broke out again, for which he was bled and purged, and the girdle put on, but without ſucceſs; for the humour ſtill continued to break out for ſeveral years in particular parts. By degrees it abated of itſelf, and he enjoyed good health for ſome years after. About the age of eighteen, he went to *Oxford*, and was very well for two years, but afterwards, by too cloſe an application to his ſtudies, and a want of freſh air and exerciſe, he grew low-ſpirited, coſtive, and got the piles. Coſtiveneſs he removed, by ſtraining for a ſtool every morning after breakfaſt. The complaints he had afterwards, though not all at the ſame time, were a lowneſs of ſpirits; an oppreſſion; an inability to bear any application of mind, or much walking; heat in his head, feet and hands; urine ſometimes foul, and ſometimes clear and limpid; ſweating; great laſſitude and inactivity; ſpitting of phlegm in the morning; a breaking out every Summer in his arms, legs and feet; in Winter, fits of bloody ſtools from the *hæmorrhoids*, and when

when thoſe ſtopped, an inattentiveneſs with heat, and ſometimes pain in the head; a ſpitting cough, and pain in the joints. About the age of thirty-ſix, I put him into a courſe of vomits, by which his blood was brought to a proper craſis, and regular motion. He took three every week for a conſiderable time; afterwards, as he gathered health and ſtrength, he diminiſhed the number, but ſtill continues to take one every ten days, and oftener, when the weather proves bad, or he is otherwiſe prevented from taking exerciſe. He now, between the ages of forty and fifty, is ſtrong, and enjoys good health.

From the beginning of this courſe, he eat any fleſh meat that was not ſalt or high ſeaſoned, and with it drank claret and water and plain claret, at dinner.

I have found by experience, that under a courſe of vomits, the diet ought to be of a ſtrengthening and warming nature.

Caſe 15. A ſtrong boy, aged about twelve years, was ſubject to an epilepſy

Spring and Autumn: of the coming on of which he always had notice for ſome time before. I took him into the Hoſpital, and purged him daily for a week, upon which the ſymptoms which uſed to precede the fits increaſed. I then changed the method, and, inſtead of purging, I vomited him every day, on which the preceding ſymptoms abated, and vaniſhed quite in ten or twelve days. And thus he was freed from a return of the fits at that time. I gave him directions what to do, and diſmiſſed him.

Caſe 16. A young man in a fever had a phrenzy on the fourth day; I ordered a vomit of two ſcruples of *Ipecacuanha*, and two grains of *emetick tartar*, which he took that day, and repeated it the fifth, ſixth, and ſeventh; and viſiting him on the eighth, I found him quite free from his phrenzy, perfectly in his ſenſes, and his pulſe reduced to a natural ſtate. But notwithſtanding he was perfectly

fectly free from any feverish motion in the blood, which was owing to a removal of all obstructions in the blood-vessels by the vomits, yet his urine was very foul, which shewed that his blood was not yet depurated, and required more time to be reduced to a healthful state. I therefore kept him to a liquid diet, and did not suffer him to eat flesh-meat for seven or eight days longer. Thus he recovered without a relapse, or any other disorder.

Case 17. A boy, between eight and nine years of age, was cured of a *Chorea Sancti Viti*, by repeated vomits, and a spoonful of *Aqua Pæoniæ composita* taken three or four times a day.

Agreeable to the practice made use of in the foregoing cases, other Physicians have recommended frequent vomits with success. Thus a Physician, who practised in *London* above one hundred and twenty years ago, commends vomits in the

the epilepſy, and fevers *(b)*. To drink the *Antimonial* cup twenty or thirty times, he ſays, will cure inveterate epilepſies, intermitting ſome days, if there be occaſion; but eſpecially vomiting towards the full and new moon. The ſame diſtemper was cured in a man, by putting his finger in his throat every morning, and provoking a diſcharge of phlegm, ſlime and wind; this, he ſays, is a great remedy, becauſe continual; for it ought to be uſed many months, or during the whole life. A man aged fifty-five years, every morning with his finger provoked a diſcharge of much phlegm from his ſtomach, lungs and head. This he had done for thirty years, and he ſtill continued to do it (when that Author wrote); by which means he preſerved himſelf in health; he fed heartily, and was never ſick. Another man, by taking the *Antimonial* cup daily

(b) General obſervations and preſcriptions in the practice of phyſick, firſt publiſhed in *London*, 1715, 8*vo*.

for

for a month or two, was cured of a pain in his ſtomach, and ſour melancholy, of many years ſtanding, which did not yield to other remedies: Antimony, ſays he, will do the ſame in an epilepſy, if they vomit with eaſe, and continue it. The ſame Phyſician greatly commends a vomiting preparation of *antimony*, prepared *ſcammony*, and *cryſtals* of *tartar*, in the cure of fevers. For this medicine will not heat, but purges hot, cholerick and thin humours, plentifully both upwards and downwards. It may be repeated every ſecond, third, or fourth day; and for the moſt part it cures not only an ardent fever, but fevers of all other kinds, whether continual or intermitting.

Doctor *Woodward* has fully ſhewn the great uſefulneſs of vomits in the cure of diſeaſes. The vomits he uſed with great ſucceſs in fevers and other diſeaſes, were *oxymel of ſquils*, *Ipecacuanha*, and *emetick tartar*. He uſed the *vinum Ipecacuanhæ*, which is not ungrateful, in perſons of weaker fibres; and in perſons

ſons of ſtronger fibres, to thirty or forty grains of *Ipecacuanha*, he added one, two, three or four grains of *emetick tartar*. He, with *Hippocrates*, ſuppoſes *all diſeaſes, which proceed from principles within the body, to ariſe from bile and phlegm.* And therefore, when theſe principles happen to abound, ſo as to cauſe diſeaſes; the true method of cure will be to correct the humours, and diſcharge them out of the body. Acids correct the bitterneſs, and acrimony of the bile; and volatile alcalies and bitters, correct the acidity and tenacity of the phlegm. If vinegar be mixed with ſtrong decoctions in water, of wormwood, gentian-root, chamomile flowers, centaury-tops, and buck-bean, the mixtures will have neither bitterneſs nor acidity, if they be mixed in juſt proportions. Hence acids and bitters correct each other, when either happens to abound too much in the body. If bile abounds, as it commonly does in ſummer and hot countries, acids and cooling acidulated liquors will be proper to cor-

rect

rect it; and if phlegm abounds, as it does in winter and cold countries, volatile alcalious ſpirits, and warming fermented liquors will be the proper correctors.

I have ſhewn in the *Animal Oeconomy (i)*, that gall leſſens the ſtrengthening power of oil, by attracting and drawing off an acid from it; and that the acid drawn off from the oil, deſtroys the bitterneſs and acrimony of the gall, may appear from the following conſiderations. Vinegar mixed with gall deſtroys the bitterneſs and acrimony of the gall. Cream of tartar and acids check the operation of vomits, but more remarkably of antimonial vomits, whoſe powerful operation is owing to the vaſt activity and power of exceeding ſmall particles, as we learn from the *Antimonial* cup preſerving its virtue for a long time without any ſenſible loſs of weight. And oil olive rubbed into the part wounded by the bite of a viper, is a

(*i*) In the tables and obſervations of prop. 25.

complete antidote againſt that poiſon, whoſe great activity depends on the exceeding minuteneſs of its volatile ſalts.

This phyſician prepared bodies for the kindly and plentiful diſcharge of bile, and other irritating matter by a vomit, by giving oil olive before hand, which weakened the fibres, and rendered them capable of greater and ſtronger motions by the *ſtimulus* of the vomit. And he promoted the operation of a vomit by milk-water, or a weak decoction of ſome dried herb not ungrateful, or ill-taſted; as of ſage, ground-ivy, or marſh-mallows, and ſometimes a glaſs of ſack; and he provoked a diſcharge by a feather. When a perſon was to be vomited with white hellebore, *Hippocrates* moiſtened the body beforehand with more copious nouriſhment and reſt.

All evacuations of the body made by ſtimulating medicines, are cauſed by the vibrating motion of the fibres, excited by the *ſtimulus* of very volatile particles of matter. And the whole vibrating motion generated in the ſame body in a given

given time, is as the force of the *ſtimulus* applied to the reſiſtance given to the motion of the fluids to be moved, and the ſtrength of the fibres upon which the *ſtimulus* acts taken together; that is, putting M for the vibrating motion generated in a given time, F for the force of the *ſtimulus*, R for the reſiſtance of the fluid to be moved, and S for the ſtrength of the fibres, M is as $\frac{F}{R \times S}$ (*k*).

Hence, to make a given vomit work plentifully, the reſiſtance of the fluids muſt be leſſened, and the fibres weakened. Heat and warm water leſſen both the reſiſtance of the fluids, and ſtrength of the fibres. They both leſſen the reſiſtance of the fluids, by leſſening their tenacity or increaſing their fluidity, and they both leſſen the ſtrength of the fibres by that propoſition. But when R and S are leſſened, and F given, M will be increaſed.

(*k*) Cor. 1. Prop. 42. *Anim. Oecon.*

Laſtly, I have been aſſured, that a Phyſician in the *Weſt Indies* cured a *Cauſus* by *Stibium* vomits.

The following obſervations on the animal fluids were made fifty or ſixty years ago, and communicated by a friend.

The *pancreatick juice* of ſheep, lambs and calves, preſſed gently out of their glands after they were dead, was thin, limpid, in taſte ſomewhat ſweetiſh and ſaline; it ſtruck the tongue with a light, ſpirituous heat, like hartſhorn. It did not inſpiſſate with heat, but evaporated to a pellicle like ſpittle, and the water contained in the eyes. Spittle and water in the eyes, did not freeze expoſed to cold air that did freeze water. So that I think a quantity of either of theſe would yield a volatile ſpirit, ſuch as urine and hartſhorn yield. Whether ſpittle and the *pituita* from the glands of the ſtomach, by that ſpirituous quality, do not ſoften the meat in the ſtomach, and promote digeſtion. Wheat and other bread-corn, when

when it is ſomewhat malted, has a fermentative quality, yielding a volatile ſpirit, its meal will not be hard bread with baking, neither any mixture of it be made ſo with heat; meal of wheat ground after malt is the ſame; ſo that a little tincture of a ſpirituous quality, may diſpoſe a conſiderable maſs of ſolids to fluidity. Whether the *pancreatick juice* mixed with bile, which will not inſpiſſate with heat nor freeze, may not paſs into the lacteals, and keep the lymph and chyle thin, and more diſpoſe the fluids of the body to motion; and whether thoſe ſpirituous particles may not be thrown off by ſecretions, before thoſe fluids inſpiſſate, and become ſolid parts.

I evaporated bile in the gall-bladder to an extract; it did not turn thin again, as extracts which contain ſalts in them will do, but grew more ſolid, and in about a fortnight kept in cold, became of the conſiſtence of hard pills, not brittle, but coheſive like a ſticking plaiſter. Its taſte was an agreeable bitter, leaving

leaving a ſweetiſh taſte; it was not glutinous although ſticking.

That which inclined me to ſuppoſe ſomething ſeptical to be in the ſtomach, which forwarded the alteration of the food into chyle, was not only the ſtinking of the excrements that paſs through the guts; but of the urine ſecreted from the chyle in the kidneys in the ſame time that the excrements are detained in the guts. I am apt to think the other ſecretion from chyle, *ſc.* perſpiration would have the ſame ſmell if its vapour were condenſed, it abounding with urinous ſalts, which are ſaid to ariſe from putrefaction, and this appears more probable, becauſe urine, blood and fleſh, will yield but little of thoſe ſalts before they have undergone a putrefaction, in compariſon of what may be drawn from them after. The *ſerum* of the blood, which contains much of thoſe ſalts, when deprived of motion ſoon ſuppurates, and the *pus* ſtinks. But the red globules will not ſo ſoon putrefy. When the *chyle* is defecated from

from thoſe ſalts in great part, and become *lympha* it will not putrefy by inſtagnation, as may be ſeen in dropſies of ſome years continuance. If barley be watered for malt, and the malſter let them ſtand together till bubbles begin to riſe in the water with ſomewhat of a whiteneſs, ſigns of its beginning to ferment; that water drawn off will ſoon ſtink much. The barly hath by it a ſweetiſh taſte, and is beginning to grow. Bodies defecated by putrefaction, will continue afterwards not diſpoſed to putrefy again. Water carried long voyages by ſea, will ſtink and then ferment, and continue always after ſweet, as ſea-men relate. [Here end the obſervations.]

In the obſervations on the two tables of *prop*. 25. of the *Animal Oeconomy*, I have ſhewn, that animal fibres are ſtronger when dry, than when they are wet with any fluid; that they are ſtronger when wet with melted fats and oils, than when wet with ardent ſpirits, or ſolutions of ſalt, eſpecially

cially common ſalt, in water; and ſtronger when wet with cold water than when wet with hot water, or with volatile alcalious ſpirits. And I have likewiſe proved, that the blood and other animal fluids, are rendered more or leſs tenacious by the things which ſtrengthen or weaken the fibres. The *Æther* is denſer in the pores of dry fibres, than it is in the pores of the ſame fibres when wet, becauſe the fibres are denſer when wet than when dry; and it has been proved, that the denſity of the *Æther* within the pores of bodies is reciprocally proportional to the denſity of the bodies. The greater denſity of the *Æther* within the pores of the fibres, preſſes the parts more ſtrongly together, and thereby increaſes the force of the coheſion of contiguous particles; and of conſequence, increaſes the ſtrength of the fibres. The more the fluid within the pores of fibres abounds with *Light*, the ſtronger will be the preſſure on the particles, and conſequently the greater will be the ſtrength of

of the fibres. Hence fibres wet with oils and oily fluids are ſtronger than fibres wet with water, thoſe fluids abounding much more with *Light* than water. Salts from their compoſition, contain much acid, that is, much *Light*; and hence it is, that when fibres are wet with ſtrong ſolutions of ſalt in water, they are much ſtronger than when wet with plain water, though not ſo ſtrong as when wet with oil.

Volatile alcalious ſpirits, and ſtrong acid ſpirits weaken the fibres of animals, by drawing off the acid or earthy part of the fibres. Heat weakens animal fibres by removing their particles to greater diſtances from one another; for the greater the diſtance of the particles is, the leſs is the force of their attraction, and, of conſequence, the weaker are the fibres.

From theſe principles, and other experiments and obſervations, I ſhall now give a more particular account of the *virtues and operations of medicines.*

I lately examined the ſtrengths of hairs of the ſame length, *viz.* ten inches, when wet with different fluids, and extended by a given weight of three hundred grains, during a given time of two minutes, and repeated each experiment till the hair would extend no farther with that weight, and then taking the reciprocal *ratio* of the extenſion for the meaſure of the ſtrength, as it is proved to be in *prop.* 35. of the *Animal Oeconomy*, I found the ſtrengthening powers to be as follows.

WATERS.

1. I tried diſtilled water, rain water, pipe-water, and ſpring-water, and found ſcarce any difference in their ſtrengthening powers. The extenſions were above twice as great, in the proportions of about 9 to 4, in a hair, whoſe extenſion when dry was 6, as they were in a hair, whoſe extenſion when dry was only $4\frac{3}{4}$.

2. I then tried tar-water, and found its ſtrengthening power to be leſs than the ſtrengthening powers of the aforeſaid waters

waters in the proportion of 43 to 40 in the ſtronger hair, and of 94 to 90 in the weaker hair. So that tar-water is ſomething leſs ſtrengthening, or more weakening than plain water. This quality of tar-water is probably owing to its volatile ſalts, which are of a weakening nature; for it agrees with volatile ſalts in its effects; they both have been known to cauſe a ſpitting of blood, when uſed conſtantly for a conſiderable time; and this they both do by thinning the blood, for thoſe things thin the blood, which weaken the fibres.

Tar-water I have known to be of conſiderable ſervice in cachectick bodies in which the motion of the fibres is leſſened, and the blood and fluids rendered more thick and tenacious than they ought to be. Tar-water has been known to be hurtful in the inflammatory fevers of young bodies. A young woman drank tar-water to prepare her for the ſmall-pox for three months or more before ſhe took the diſtemper, and had the worſt kind of the confluent pock,

of which ſhe died. In ſhort, tar-water may often fail in preventing and curing the diſorders of young bodies, which have ſufficient heat and motion in their blood and juices; and yet may be of great uſe in bodies of a more advanced age, who, from long errors in the non-naturals, have loſt the natural heat and motion of the blood, and are become cacheƈtick; particularly in bodies who have loſt their appetites by drinking ſpirituous liquors.

BITTER JUICES.

3. I tried the juices of common wormwood, ſcurvy-graſs and rue, with a hair whoſe extenſion, when dry, was 5 diviſions of the ſcale. The extenſion, when the hair was wet with juice of wormwood, and afterwards with juice of ſcurvy-graſs, was 63; when wet with juice of rue it was 67; and laſtly, when wet with pipe-water, it was 70. Hence it appears, that the juices of wormwood and ſcurvy-graſs are equally ſtrengthening, and both a little more ſtrengthening

ing than the juice of rue; and they all are ſomething more ſtrengthening than pipe-water.

BITTER DECOCTIONS.

4. I tried very ſtrong decoctions of common wormwood, gentian-roots, chamomile-flowers, centaury-tops, and buck-bean in water; and the *Infuſum amarum ſimplex* of the *New* London *Diſpenſatory*, with a hair, whoſe extenſion, when dry, was $5\frac{1}{2}$; and found the extenſion cauſed by the decoction of wormwood to be 96, by that of gentian $95\frac{1}{2}$, by that of chamomile-flowers, and centaury 97, by that of buck-bean 99, and by the *Infuſum amarum ſimplex* 98. The ſtrengths of theſe bitter decoctions were according to the order in which they are here placed, that of wormwood was the ſtrongeſt, and that of buck-bean the weakeſt.

Vinegar mixed with theſe decoctions produced an effervefcence on mixing, and when they were mixed in a juſt proportion, the mixture had neither acidity

dity nor bitterneſs. So that acids and bitters correct each other, when either happens to abound too much in the body. In phlegmatick and low conſtitutions, in which the *pituita* and acid phlegm is apt to abound, bitters will be proper correctors of the phlegm; and where bitters abound, as in a redundant and highly exalted bile, there acids will be proper to correct the bile, which is an exceedingly bitter fluid.

This Spring I tried ſome experiments concerning the ſtrengthening powers of the ſame hair, when wet with different fluids, and I repeated the experiment with each fluid till the hair would extend no farther; ſo that the reciprocal *ratio* of the laſt extenſion is the true meaſure of the ſtrength of the hair, when wet with that fluid. Let N denote the number of experiments till the hair would extend no farther, and E the extenſions of the firſt and laſt trials.

Dry

	N.	E First	E Last
Dry - - - - - - - - - - - - -	2	6	6
A ſtrong ſolution of Soap - -	3	101	103
Pipe-water	4	100½	90
Ox's gall -	6	102	104½
Pipe-water	2	105	105
Sheep's gall	3	105	105½
Pipe-water	3	106	106
Calf's gall	3	107	107
Pipe-water	3	108	107½
Pig's gall	5	105	108½
Pipe-water	4	107	108

I tried the following fluids with a hair, whoſe extenſion when dry was 4, and took their extenſions, when wet with the ſeveral fluids here mentioned. The method I uſed was this. As ſoon as I had got the extenſion by wetting it with one fluid, I preſently for a given time of two minutes waſhed it with another fluid, and took the extenſion of that the ſame time, and thus I proceeded till I had gone through the whole.

	E.
Dry - - - - - - - - - - - - - - - - - - -	4
Wet with ſkim'd Milk - - - - - - - -	21
Pipe-water cold - - - - - -	33
Oil olive - - - - - - - - - - -	$6\frac{1}{2}$
A ſtrong ſolution of common Salt - - - - - - - -	7
Pipe-water cold - - - - - - -	25
Freſh urine - - - - - - - - - -	24
Woman's milk cold - - - - -	18
Cream of cow's milk - - -	$9\frac{1}{2}$
Butter-milk - - - - - - - -	15
Ox's gall - - - - - - - - - - -	19
Calf's gall - - - - - - - - - - -	21
Sheep's gall - - - - - - - - -	21
Pig's gall - - - - - - - - - - -	$21\frac{1}{2}$
Spirit of wine rectified - - -	7
Lixivium tartari - - - - - -	$8\frac{1}{4}$
Sp. *volatilis aromaticus* - - -	$7\frac{1}{4}$
Water hot - - - - - - - - - -	23
Pipe-water cold - - - - - -	19
The ſame woman's milk as above - - - - - - - - - -	20
Sp. of *ſal armoniac*, firſt trial	33

From theſe experiments we learn that when the fibres are rendered too ſtrong or too weak, and the fluids too thick or too thin by one ſort of diet, the evil, if

if it be not of a long ſtanding, may ſoon be corrected by uſing a diet of a contrary nature.

Gum Reſins diſſolvable in water.

	N.	E. First	E. Laſt
Dry - - - - - - - - - - - - -	2	4½	4½
Wet with Galbanum diſſolved in water - - - - - -	4	23	49
Pipe-water - - - -	2	48½	48
Aſa-fœtida - - -	3	45	44½
Myrrh - - - - - -	2	48	48
Ammoniacum - -	2	48	48
Sagapenum - - -	4	34	44
Opoponax - - - -	2	43	43
Olibanum - - - -	3	46	47
Scammonium - -	3	34	44
Gutta-gamba - -	3	44	44½
Pipe-water - - - -	3	40	44

Gums are of very differentt and contrary qualities; ſome purge, as *Sagapenum* and *Opoponax*; ſome incraſſate, as *Arabick* and *Tragacanth*. Some are of thin parts, as *Gum Ammoniacum* which powerfully ſcattereth hard and ſchirrous

 tumors;

tumors; and *Galbanum*, which being diſſolved in vinegar, and applied as a cerat, often diſſolves coagulated milk in the breaſts of nurſes.

N. B. Fifteen grains of each of the gums was diſſolved in one drachm of water.

Four or five days after I had tried the ſtrengthening powers of Gum Reſins diſſolvable in water, I tried with the ſame hair the ſtrengths of the following Balſams and Gum Reſins diſſolvable in water by being mixed with *Gum Arabick*. In theſe experiments fifteen grains of the Balſams and Gums, mixed with three grains of *Gum Arabick* in the four firſt, and with ten and four grains of *Gum Arabick* in the two laſt, were diſſolved in one drachm of water.

Balſams and Gum Reſins diſſolvable in water, by being mixed with *Gum Arabick.*

	N.	E. First	E. Last
Dry - - - - - - - - - - - - - -	2	4½	4½
Wet with Balſam Capivi - -	5	14	30
Balſam of Peru -	3	35	39
Benjamin - - - -	3	43	44
Bdellium - - - -	4	38	46
Balm of Giliad -	3	35	46
Maſtick - - - - -	2	46	44

	N.	E. First	E. Laſt
Dry - - - - - - - - - - - - -	2	5	5
Wet with Camphire diſſolved	4	62	74
Spiritus myndereri -	4	62½	66
Linimentum ſapon.	4	28	74
Pipe-water - - - -	5	76	64
Linimentum volatile	4	68	70
The ſame hair next day.			
Dry - - - - - - - - - - - - - -	2	5	5
Wet with Tinct. Saturnina -	6	55	90
Sp. of wine rectif. -	3	72	82
Oil olive - - - - -	4	31	25
The ſame the third day.			
Dry - - - - - - - - - - - - -	2	15	15
Wet with pipe-water - - -	2	76	76
diſtilled vinegar -	4	79	86
a *lixivium* of ſal. diu.	2	8	8
a ſtrong ſolution of ſal. diu. in water	3	9½	10

When

When I came to try this hair the third day, I found it wanted $7\frac{1}{2}$ degrees of its firſt height, and it ſunk $7\frac{1}{2}$ degrees more by the given appended weight; ſo that the whole extenſion from the firſt height, was 15. The ſtrengthening power of this *lixivium* is greater than the ſtrengthening power of the ſtrongeſt ſolution of this ſalt in water.

I have tried the following tinctures of the *New* London *Diſpenſatory*, and found them to be as in the following page.

TINCTURES,

TINCTURES, &c.	N.	E. First	E. Last
Dry - - - - - - - - - - - - -	2	4½	4½
Wet with Tinct. amara - - -	3	75	82
Aromatica -	4	83	88
Cantharidum	3	83½	87
Cort. Per. sim.	4	81	87
Castorei - - -	2	84	84
Fœtida - - -	6	47	79
Fuliginis - -	2	87	87
Japonica - -	3	84	88
Styptica - -	3	85	87
Rhubarb spir.	3	97	98
Guaj. volat. -	7	24	92
Another hair.			
Dry - - - - - - - - - - - - - -	2	5¾	5¾
Wet with Tinct. Myrrhæ - -	7	14	93
Pipe-water - - -	3	94	96
Tinct. Melampodii	3	89	94
Valerianæ -	3	90	96
Rhab. spir. -	3	97	98
Senæ - - -	2	95	95
Flor. mart. -	11	57	96
Serpentariæ -	3	93	98
Mart. in sp. sal.	7	55	85
Serpentariæ -	2	104	105
Dry - - - - - - - - - - - - - -	2	5½	5½
Wet with Vinum chalybeatum	2	66	74
Aq. Junip. comp. -	2	64	76
Uncis muschatæ -	2	68	76
Elix. vitriol. acid. -	2	8	8
dulce	8	39	77½
acid -	2	39½	33

I have

I have ſhewn in the tables and obſervations of *prop.* 35. of the *Animal Oeconomy*, how the fibres of human bodies are affected as to their ſtrengths by being wet with different fluids, and how the ſtrengthening powers of two fluids are altered by their being mixed together. The hairs I uſed in compoſing thoſe tables were all of the ſame ſtrength when dry; for they were all ten inches long, and were all extended five diviſions of the ſcale, by a weight of three hundred grains acting upon them for two minutes of time; and when all theſe are given, the ſtrength of a hair will be meaſured by the reciprocal *ratio* of its extenſion produced in a given time, that is, putting E and e for its extenſions, when dry and when wet, in the given time, by $\frac{1}{E}$ and $\frac{1}{e}$, or by 1 and $\frac{E}{e}$; for $\frac{1}{E}$ is to $\frac{1}{e}$, as 1 is to $\frac{E}{e}$; or as 100000 to $\frac{100000\,E}{e} = \frac{500000}{e}$, when E is 5.

If, inſtead of being wet with one fluid, the hair be wet with a mixture of

of two fluids, the ſtrengths of which ſeparately are denoted by A and B, and if the quantities of the fluids in the mixture be denoted by m and n; and if the two ingredients have the ſame ſtrengthening powers in the mixture, which they had before mixing; the ſtrength of the hair, when wet with the mixture, would then be $\frac{mA+nB}{m+n}$; whereas, in reality, it is meaſured by $\frac{E}{e}$, e denoting the extenſion of the hair when wet with the mixture.

The firſt of the two following tables, is the ſecond table of the aforeſaid propoſition; and is formed by dividing the numbers in the laſt column of that table, expreſſing the ſtrengths of the wet hairs by the theory, by the correſponding numbers in the preceding column, expreſſing their true ſtrengths by experiment. By this means the *ratio* of the ſtrength by experiment to the ſtrength by the theory, will not be changed, only the table will be more ſimple, the

ſtrength

ſtrength by experiment being always expreſſed by 10000.

In the ſecond of the following tables I tried the ſtrengths of oil-olive, tar-water, ſea-water, vinegar and ſheep's gall, both ſeparately and in mixture, with a hair, whoſe extenſion when dry was $5\frac{1}{2}$ diviſions of the ſcale. The ſpecifick gravities of the oil, tar-water, ſea-water, vinegar and gall, were 9292, 10026, 10182, 10208 and 10286; the extenſions, when the hair was wet ſeparately with theſe fluids, were $8\frac{1}{2}$, 91, 87, 95 and 92; and its ſeparate ſtrengths, found by dividing 550000 by theſe extenſions, were 64706, 6044, 6322, 5789 and 5914.

TABLE I.

	Strength of a fibre from experiments.	Its ſtrength according to the mixture.
Dry -	100000.	
Wet with 2 parts of oil-olive, and 1 part of ſheep's-gall, mix'd - - -	10000	37616
2 parts of good brandy, and 1 part of ſheep's gall, mix'd - -	10000	26443
2 parts of cream of cows milk, and 1 part of ſheep's gall, mix'd	10000	13505
2 parts of *French* claret, and 1 part of ſheep's gall, mix'd - -	10000	11252
2 parts of meath, and one part of ſheep's gall, mix'd - - -	10000	10592
2 parts of a ſtrong ſolution of common ſalt, and 1 part of ſheep's gall, mix'd - - - - - - - - - - - - - - - - -	10000	10054
2 parts of lemon-juice, and 1 part of ſheep's gall, mix'd - -	10000	9777
2 parts of ſalt of tartar *per deliquium*, and 1 part of ſheep's gall, mix'd -	10000	7366
2 parts of oil-olive, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	62419
2 parts of good brandy, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	28505

TABLE I.

	Strength of a fibre from experiments.	Its ſtrength according to the mixture.
Wet with 2 parts of cream of cow's milk, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	15276
2 parts of *French* claret, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	12414
2 parts of meath, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	10439
2 parts of a ſtrong ſolution of common ſalt, and 1 part of ſpirit of ſal-armoniac, mix'd - - - - - - - - - - - - - - -	10000	10336
2 parts of lemon-juice, and 1 part of ſpirit of Sal-armoniac, mix'd -	10000	8379
2 parts of ſalt of tartar *per deliquium*, and 1 part of ſpirit of Sal-armoniac, mix'd	10000	9054
2 parts of a ſtrong ſolution of nitre, and 1 part of ſpirit of Sal-armoniac, mix'd - - - - - - - - - - - - - - - - - - -	10000	19724

TABLE II.

	Strength by	
	Experim.	Theory.
Dry -	10000	
Wet with 2 parts of oil-olive, and 1 part of ſheep's gall, mix'd - - - -	10000	73809
2 parts of oil-olive, and 1 part of tar-water, mix'd - - - - - -	10000	61561
2 parts of oil-olive, and 1 part of ſea-water, mix'd - - - - -	10000	46149
2 parts of tar-water, and 1 part of ſheep's gall, mix'd - - -	10000	10258
2 parts of ſea-water, and 1 part of ſheep's gall, mix'd - - - -	10000	10542
2 parts of tar-water, and 1 part of vinegar, mix'd - - - - - -	10000	10509
2 parts of ſea-water, and 1 part of vinegar, mix'd - - - - - -	10000	10004

Obſervations on the Tables, and on Gall.

Obſ. 1. By Table II. the ſtrengthening power of oil is more weakened by the gall of animals, than by tar-water, and more by tar-water than by ſea-water. I have ſhewn in the aforeſaid tables of the *Animal Oeconomy*, that gall weakens the ſtrengthening power of oil by drawing off an acid from it, on which acid its ſtrengthening power depends.

Obſ. 2. The gall of animals is very bitter, with ſomewhat of a ſweetiſh taſte.

Obſ. 3. The colour of the gall is of the fourth order of colours in Sir *Iſaac Newton*'s table, which order contains, *bluiſh green, green, yellowiſh green, red.* The tinging corpuſcles of the *bluiſh green* are the leaſt, and the tinging corpuſcles

puſcles of the *red*, are the greateſt corpuſcles of this order *(l)*.

Hence, by carefully obſerving the colour of the gall, we may form ſome idea of the magnitudes of its tinging corpuſcles; and conſequently, know how thoſe magnitudes are affected by a difference of age, by different kinds of food, different degrees of heat, by fatneſs and leanneſs, and by a difference in other circumſtances. When the gall changes its colour from a bluiſh green to a yellowiſh green, its tinging corpuſcles are enlarged; and they are leſſened, when the change is made from a yellowiſh green or orange, to a bluiſh green.

Obſ. 4. The galls of two ſheep, a very fat and a very lean one, weighed 400 and 1020 grains; and the weights of the two ſheep were judged to be as about 4 to 3. Both the galls were bitter, but that of the lean ſheep was

(l) See table, p. 206 of the *Opticks*; and p. 88 of the *Diſſertation on the Æther of Sir* Iſaac Newton.

much

much bitterer, more tenacious and ropy, and of a darker colour, than the gall of the fat ſheep. The colour of the gall of the lean ſheep was a bluiſh green, and the colour of the gall of the fat ſheep a yellowiſh green like the colour of a goſling.

The quantity, heat, and motion of the blood, are all of them greater in lean ſheep, than in fat ſheep. Hence we learn, that when a lean ſheep grows fat, the tinging corpuſcles of the gall are enlarged, as they ought to be, from a diminution of the heat and motion of the blood. For heat divides and ſeparates the tinging corpuſcles of gall, or its particles of the *laſt compoſition*, on which its colour depends. The bitter taſte of the gall of the lean ſheep, though ſtronger, yet was more agreeable, than the bitter taſte of the gall of the fat ſheep, which had a kind of diſagreeable roughneſs. There was ſomething of a ſweetiſh taſte in both, but more in the gall of the fat ſheep, than in that of the lean ſheep.

Obj.

Obs. 5. I examined the galls of a calf and an ox. The colour of the calf's gall was a dirty orange, with little or no tincture of green, and its taste was sweetish, with very little bitter. The colour of the ox's gall was a yellowish green, and its taste much bitterer than the calf's, with much less sweetness. The calf's gall was very fluid; and that of the ox was very tenacious and ropy.

Hence, the tinging corpuscles of the calf's gall are larger, than the tinging corpuscles of the gall of the ox.

Obs. 6. The gall of sheep fed on hay, is bitterer, and of a deeper colour, and its tinging corpuscles are less; than the gall of sheep fed on grass.

From these two observations, we see how the gall is changed by a difference in age, and a difference in diet.

Obſ. 7. Two parts of the gall of a fatter and a leaner ſheep, were mixed with one part of *ſpirit* of *ſal-armoniac*; and each mixture was thinner, paler and more pungent than the gall alone before mixing.

Obſ. 8. Two parts of the gall of the ſame ſheep, being each of them mixed with one part of *rectified ſpirit of wine*; the two mixtures at firſt effervefced, but the effervefcence of the gall of the leaner ſheep was much greater and continued longer, than the effervefcence of the gall of the fatter ſheep. The conſiſtence of the mixture of the gall of the fatter ſheep was thicker, and its colour deeper, than were thoſe of the gall before mixing. And the conſiſtence of the mixture of the gall of the leaner ſheep was thinner, and its colour paler, than were the conſiſtence and colour of the gall before mixing.

Obſ. 9. Two parts of the gall of the ſame ſheep, being mixed with one part of *vinegar*; the mixtures efferveſced a little, and that of the leaner ſheep more than that of the fatter. Both the mixtures taſted ſweetiſh, without any ſourneſs; that of the fatter ſheep had no bitterneſs, but that of the leaner had ſome, though not what was equal to that of its own gall.

Obſ. 10. Two parts of the gall of the ſame ſheep, were mixed with one part of *ſpirit* of *vitriol*; and the efferveſcence was greater in both mixtures than it was in the mixtures with *vinegar*; and it was greater in the mixture of the gall of the leaner ſheep, than in that of the fatter. The taſte was acid and ſweetiſh in both, without almoſt any bitterneſs, except in that of the leaner ſheep, which had a little bitterneſs after the efferveſcence was over.

Obſ. 11. Two parts of the gall of the ſame ſheep, mixed with one part of *lixivium tartari* produced no efferveſcence. The taſte of both was ſweet, without any ſourneſs. Both mixtures had a little bitterneſs, and that of the leaner ſheep ſomething more than that of the fatter. The colour and conſiſtence of both the mixtures were much the ſame with the colour and conſiſtence of their reſpective galls, only they were a little different in the mixture of the gall of the leaner ſheep.

Obſ. 12. Two parts of a ſheep's gall mixed with one part of *tar-water*, produced no efferveſcence. The colour of the gall was a bluiſh green, and that of the tar-water a faint yellow. The taſte of the ſheep's gall was very bitter, with a little ſweetneſs; and the taſte of the mixture was not ſo bitter, but ſomething ſweeter, with a little pungency.

Obſ. 13. Two parts of a lamb's gall mixed with one part of *tar-water*, produced no effervеſcence. The colour of the mixture was yellower than that of the gall, but the mixture not ſo bitter. The pungency or acrimony was greater than in the mixture of the ſheep's gall, but much leſs than the pungency of tar-water.

Obſ. 14. A pig's gall was very yellow, or rather orange, without any blue. The gall by itſelf and mixed with tar-water, were both ropy. The gall was not ſo bitter as the lamb's gall.

Obſ. 15. Two parts of the gall of a cod mixed with one part of *tar-water*, produced a very ſmall effervеſcence. The colour of the gall of the cod was a very fine green, a good deal deeper than the colour of the mixture. The mixture was thinner than the gall alone; and taſted ſtronger of tar-water, than the mixtures in *Obſ.* 12. and 13.

In

In the third obſervation, I have ſhewn, that the colour of the gall is of the fourth order of colours in Sir *Iſaac Newton*'s table in his *Opticks*, which order contains *bluiſh green*, *green*, *yellowiſh green*, *red*; and that the tinging corpuſcles of the *bluiſh green* are the leaſt, and the tinging corpuſcles of the red the biggeſt corpuſcles of that order. The thickneſſes of the tinging corpuſcles of water, which exhibit theſe colours are $25\frac{1}{2}$, $26\frac{1}{2}$, 27 and $30\frac{1}{4}$ parts of an inch divided into 1000000 parts, by the table in the *Opticks*; and the $\frac{1}{39215}$th, $\frac{1}{37136}$th, $\frac{1}{37037}$th and $\frac{1}{33057}$th part of an inch, by the table in the *Diſſertation on the Æther*.

By knowing the colour of the gall, we know the magnitude of its tinging corpuſcles; and by knowing the magnitude of its tinging corpuſcles, and how that magnitude is changed by a difference of age, of food, of heat, of weight of the body, of exerciſe, and of other things; we know how the virtues and

powers

powers of the gall are changed; and from this knowledge, a THEORY of diſeaſes may be compoſed, which ſhall agree with true Philoſophy; and with the doctrine of *Hippocrates*, namely, that *all diſeaſes in men ariſe from* BILE *and* PHLEGM.

MERCURY.

Mercury or quickſilver is a very fluid metal of the colour of ſilver, very heavy, and yet volatile. Mercury is volatile, and is eaſily raiſed by heat, becauſe its particles of the *laſt compoſition* are ſmall, and are eaſily ſeparated from one another, from the weakneſs of their coheſion. Theſe being ſeparated by a gentle heat, repel one another, like the parts of air and vapour. That the particles of mercury of the *laſt compoſition* are ſmall, may be gathered from its colour, which is the white of the firſt order. The thickneſs of the ſkins of bubbles of water which reflect the white of the firſt order is the $\frac{1}{258064}$th part of an inch. But to gather the bigneſs of metallick

tallick

tallick particles, we muſt allow for their denſity. For, was mercury tranſparent, its denſity is ſuch, that the ſine of incidence upon it would be to the ſine of refraction, as 7 to 2. And therefore the thickneſs of the particles, that they may exhibit the ſame colour with thoſe of bubbles of water, ought to be leſs than the thickneſs of the ſkin of thoſe bubbles of water, in the proportion of 2 to 7, that is, the thickneſs of the particles of mercury of the *laſt compoſition* ought to be the $\frac{1}{903224}$th part of an inch. Whence it is poſſible, that the particles of mercury may be as ſmall as the particles of ſome tranſparent and volatile fluids, and yet reflect the white of the firſt order.

Mercury is attracted and corroded by acids, as appears from its being diſſolved by *aqua fortis*. A ſolution of mercury in *aqua fortis*, being poured upon iron, copper, tin or lead, diſſolves the metal, and lets go the mercury; which ſhews, that the acid particles of *aqua fortis* are more ſtrongly attracted by iron, copper, tin and lead, than by mercury.

mercury. But notwithſtanding mercury attracts acids leſs ſtrongly than other metals do, yet a conſiderable part of its virtue, conſidered as a medicine, ſeems to conſiſt in this power. And if to the power of attracting acids, be joined its great volatility and weight, by which it becomes capable of being introduced into the blood, and of removing obſtructions in the capillary veſſels, we ſhall have the whole virtue of mercury conſidered as a medicine.

Mercury, by attracting and drawing off the acid from venereal ſalts, and thereby deſtroying their great activity and power, cures the *lues venerea*, when introduced into the blood by unction. A ſalivation raiſed by *calomel*, takes off the ſymptoms for the preſent, but it ſeldom cures the diſeaſe; for they are apt to return in five or ſix months, or ſooner. But this ſeldom happens, when a ſalivation is raiſed by unction, provided, when the ſalivation is over, a decoction of *Guaiacum* be drunk in a ſufficient quantity for ſome time. Sometimes mercury will

will not ſalivate, but goes off by urine or perſpiration, and cures as effectually as when it raiſes a ſalivation. In ſome caſes, none of theſe diſcharges will be viſibly promoted by mercury, and yet the diſtemper will be effectually cured. Other caſes there have been, where perſons have ſalivated plentifully, and yet not been cured.

Perſons who have had no venereal diſorders for ten or twelve years, and have then been ſeized with nocturnal pains, have been cured by a ſalivation. Some caſes are incurable, where the venereal poiſon has, by length of time, infected the bones, and ſo diffuſed itſelf and infected the whole body, as not to be deſtroyed by mercury. Venereal eruptions and ulcers on the external parts of the body are eaſieſt cured by mercury, when pains of the head, ſhoulders, ſhins, *&c.* ſometimes remain unremoved.

Mercury neither cures ſcorbutick nor ſcrophulous diſorders. The reaſon may be, that mercury has not power ſufficient to draw off the acid of thoſe ſalts from the central earth.

Scrophulous perſons ſalivate with difficulty, which may be owing to the ſwelling of the meſenterick glands, which makes ſuch perſons ſubject to fluxes, which may cauſe the mercury to paſs off that way.

Perſons with carious bones ſalivate with difficulty, the mercury getting into the carious bones. Bones ſeldom become carious but from venereal or ſcrophulous cauſes, or from the matter of abſceſſes.

In high ſcorbutick caſes, mercury often cauſes very ſordid ulcers in the mouth.

In perſons ſalivated in venereal caſes, the ulcers commonly begin to heal in ſix or ſeven days after the laſt unction.

Mercury often cures ſtubborn ulcers, though not venereal.

On moſt perſons who have taken much mercury, a ſalivation cannot be raiſed by any means, and they will hardly purge with purges twice as ſtrong as thoſe which would have purged them before.

Children

Children of thoſe who have had the venereal diſeaſe, and have taken much mercury, are very ſubject to ſtrumous ſwellings; and often die of the ſmall-pox, though the diſeaſe be of the diſtinct kind.

Mercurius dulcis taken in ſmall quantities, till the mouth begins to grow ſore, and a ſlight ſalivation begins to ariſe, often cures an *opthalmia*, bleeding before, and purging after it.

Mercury, with all its preparations, is an enemy to weak nerves.

Milk ſooner reſtores bodies after a ſalivation, than other food.

The great velocities of the minute particles of bodies in their accelerated motions, cauſed by *Light*, may in ſome degree be illuſtrated by the following propoſition and tables.

PROPOSITION.

If a primary planet be deprived of its circular motion round the Sun, and left to the ſole influence of the force of gra-

vity; that force will make it to descend to the center of the Sun with an accelerated motion, and bring it to the center in half the periodick time that another body would revolve about the Sun, when placed at half the diſtance from its center *(m)*. Let T and t denote the periodick times of the planet before it be deprived of its circular motion, and of the other body revolving about the ſun at half the diſtance; and let D and d denote thoſe diſtances, which are as 2 and 1. And then the periodick times of the planet and of the other body, will be in the ſeſquiplicate *ratio* of the diſtances; that is, T . t :: $D^{\frac{3}{2}} . d^{\frac{3}{2}} :: D\surd D . 1 :: 2\surd 2 . 1.$ whence $t = \frac{T}{2\surd 2}$, and $\frac{t}{2} = \frac{T}{4\surd 2}$. But $\frac{t}{2}$ expreſſes the time of the planets deſcent to the center of the Sun. And therefore the ſame time will be expreſſed by $\frac{T}{4\surd 2} = \frac{T}{5.65685425}$.

(*m*) Prop. 36. *Princip. Newtoni.*

The

The periodick times of the primary planets round the Sun, and of the ſecondary planets (or ſatellites) round their primary ones, are expreſſed in days and decimal parts: Table I. contains both the periodick times of the primary planets, and of their ſatellites; and the times of their deſcents by the ſingle force of gravity to the bodies about which they revolve, expreſſed in days and decimal parts. And Table II. contains the diſtances of the primary planets from the center of the Sun, expreſſed in *Engliſh* miles and decimal parts; and the mean velocities acquired in deſcending to the Sun by the force of gravity, expreſſed in *Engliſh* miles and decimal parts deſcribed in one ſecond of time.

TABLE I.

Primary.	Satelites.	The periodick times of the revolutions of the planets about their centers of motion, in days and dec. parts.	Times in which they would fall to those centers when deprived of their circular motion, in days and dec. parts.
Saturn -		10759.2750	1901.98908
	1	1.8878	.33370
	2	2.7371	.48386
	3	4.5175	.79859
	4	15.9453	2.81876
	5	79.3250	14.02281
Jupiter -		4332.5140	765.88751
	1	1.7691	.3[illegible]275
	2	3.5512	.62777
	3	7.1546	1.26477
	4	16.6890	2.95023
Mars - -		686.9785	121.44180
Earth - -		365.2565	64.56884
	1	27.3215	4.82980
Venus -		224.6176	39.70716
Mercury		87.9692	15.55090

TABLE

TABLE II.

Primary Planets.	Distance from the center of the Sun, in *English* miles and dec. parts.	Mean velocity with which they would fall to the center of the Sun, in one second of time, expressed in *English* miles, and dec. parts.
Saturn - -	743070694.1712	4.52177
Jupiter -	405061333.1792	6.12131
Mars - -	118679482.7288	11.31084
Earth -	77889520.0000	13.96167
Venus -	56339826.5016	16.42455
Mercury	30151033.1920	22.44053

By

By comparing the means of the accelerated velocities of the primary planets deſcending by the force of gravity to the Sun, with their velocities in their orbits ſet down in Table I. p. 46, of the *Diſſertation on the* Æther *of Sir* Iſaac Newton, it appears, that the mean velocities acquired by the force of gravity in their deſcent to the Sun, are ſomething leſs than the velocities in their orbits. And it likewiſe appears, by comparing the ſecond of the following Tables with the Table above in p. 10, that even the ſloweſt of theſe accelerated velocities acquired in the fall, is much greater than the velocity of a cannon-ball, when it leaves the gun. But though theſe velocities of the planets at the end of their fall to the Sun, be very great; yet they are far ſhort of the accelerated velocities in the minute particles of matter cauſed by *Light*.

F I N I S.